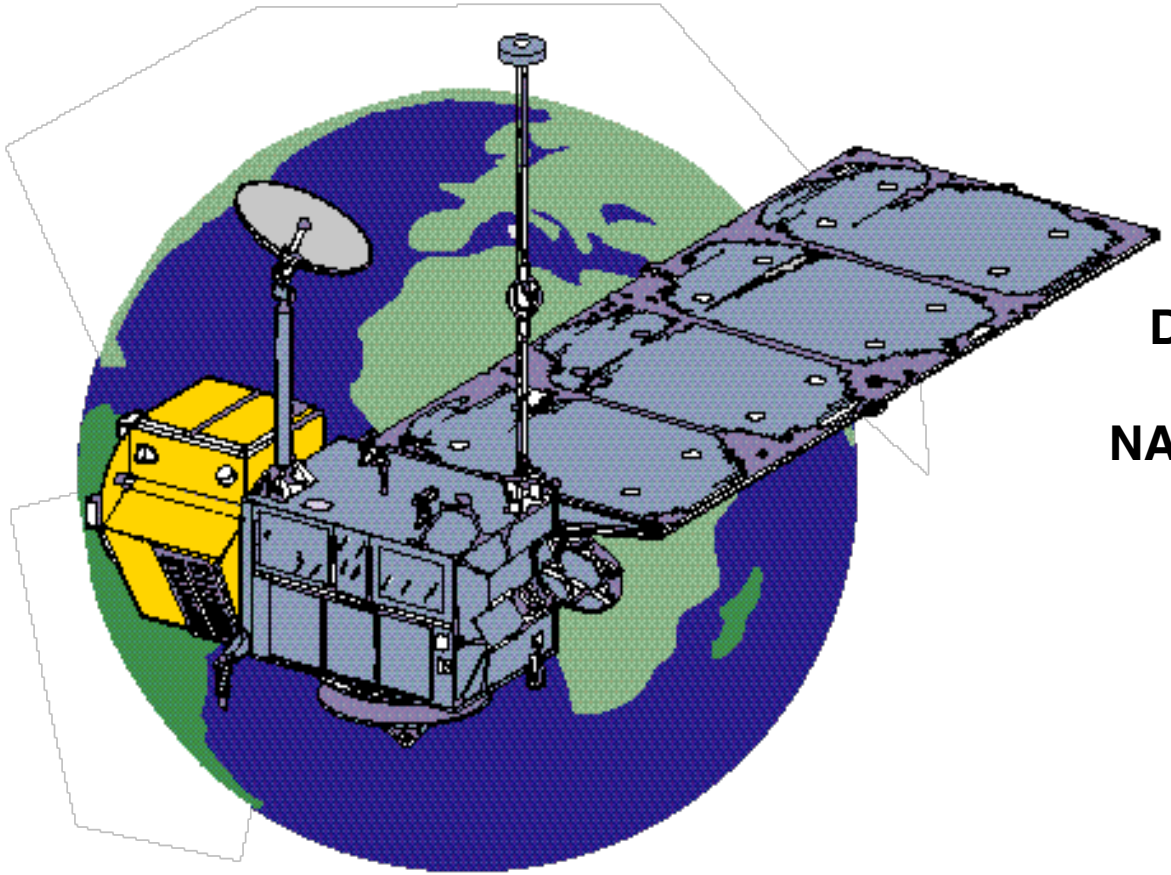
TOPEX/Poseidon

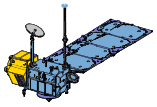
Satellite/Sensors Performance Characteristics Workshop #13



Presented By:
Martin Nachman
Jet Propulsion Laboratory

Prepared By:
Dennis Lockwood/Raytheon ITSS
David Hancock
NASA/GSFC Wallops Flight Facility

Presented At:
JPL
August 10, 2004



TOPEX Side A

Turned On: August 21, 1992
Turned Off: February 9, 1999

Total Hours from Turn On to Turn Off:

OFF	394
IDLE	6,100
TRACK	50,200

TOPEX Side B

Turned On: February 10, 1999

Total Hours from Turn On through August 4, 2004 (2004217):

OFF	443
IDLE	2,170
TRACK	45,400

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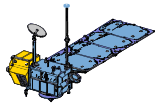

Side B Status

- Side B continues to operate well.
- Cal Sweep Tests are performed every data cycle, to discern any Side B PTR changes. None detected.
- Issued “TOPEX Radar Altimeter Engineering Assessment Report - Update: Side B Turn-On to January 1, 2004”, April 2004. (http://topex.wff.nasa.gov/Documents)
- No significant concerns.

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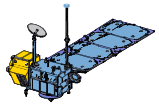

Effects of Degradation of Spacecraft Subsystems on Altimeter Performance

- Data Recorder performance has reduced data capture to about 21.5 hours daily
- Reaction Wheel performance induced Large Attitude Angles
  - Altimeter does not remain in Fine Track when attitude angle exceeds 0.7 degrees
  - Algorithms do not provide quality data when attitude angles exceed 0.45 degrees.
  - No harm to altimeter hardware

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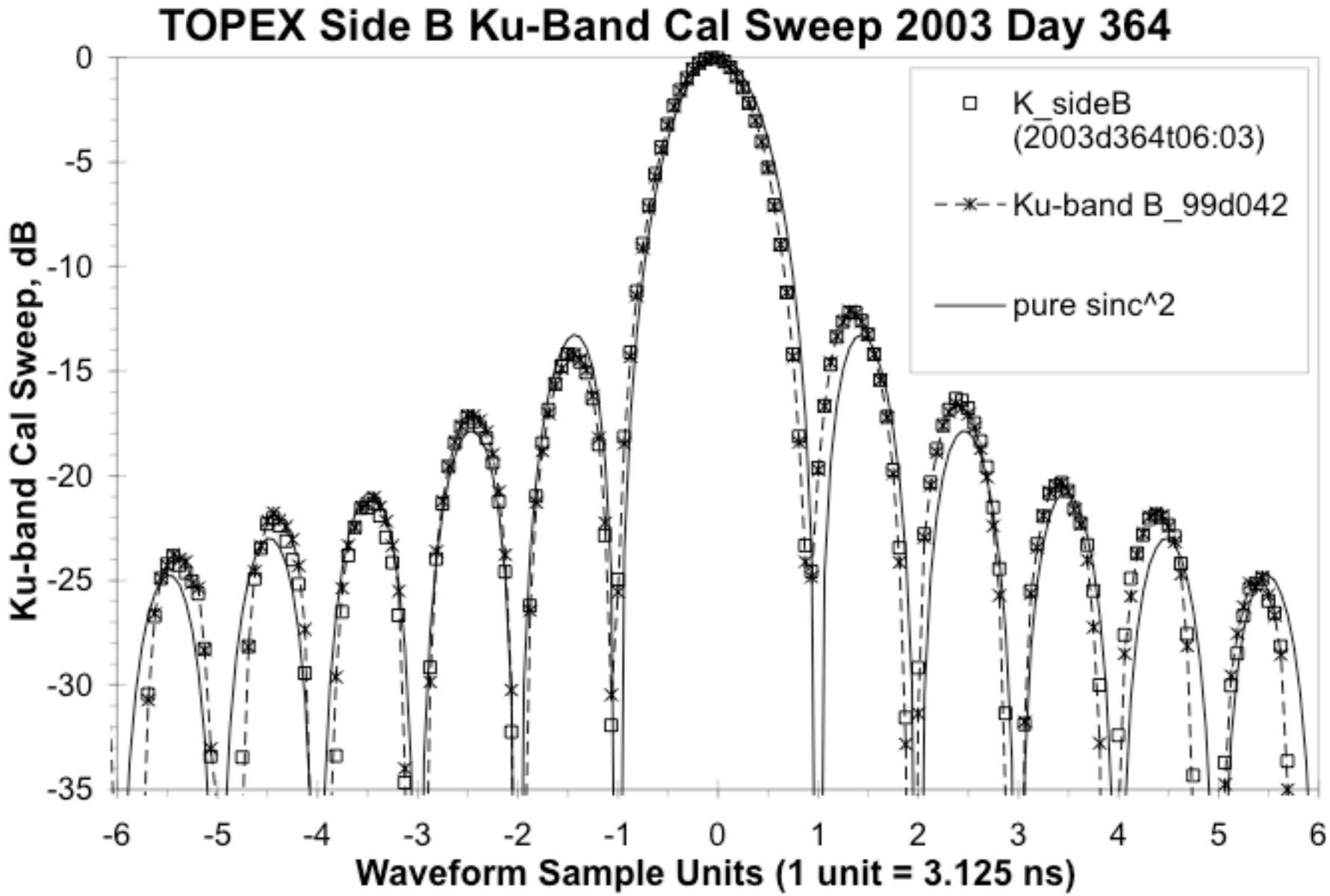
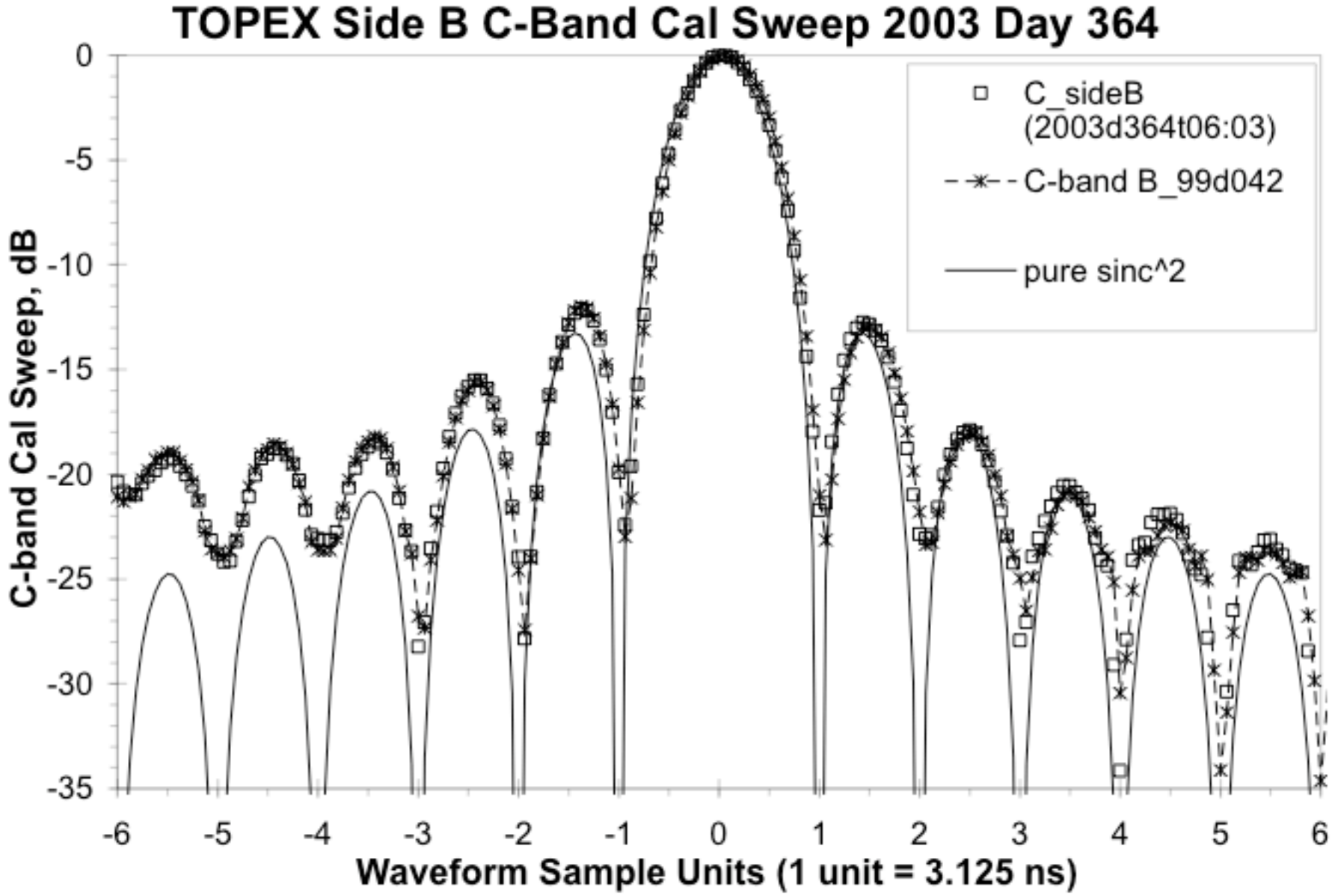
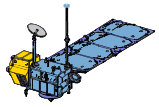
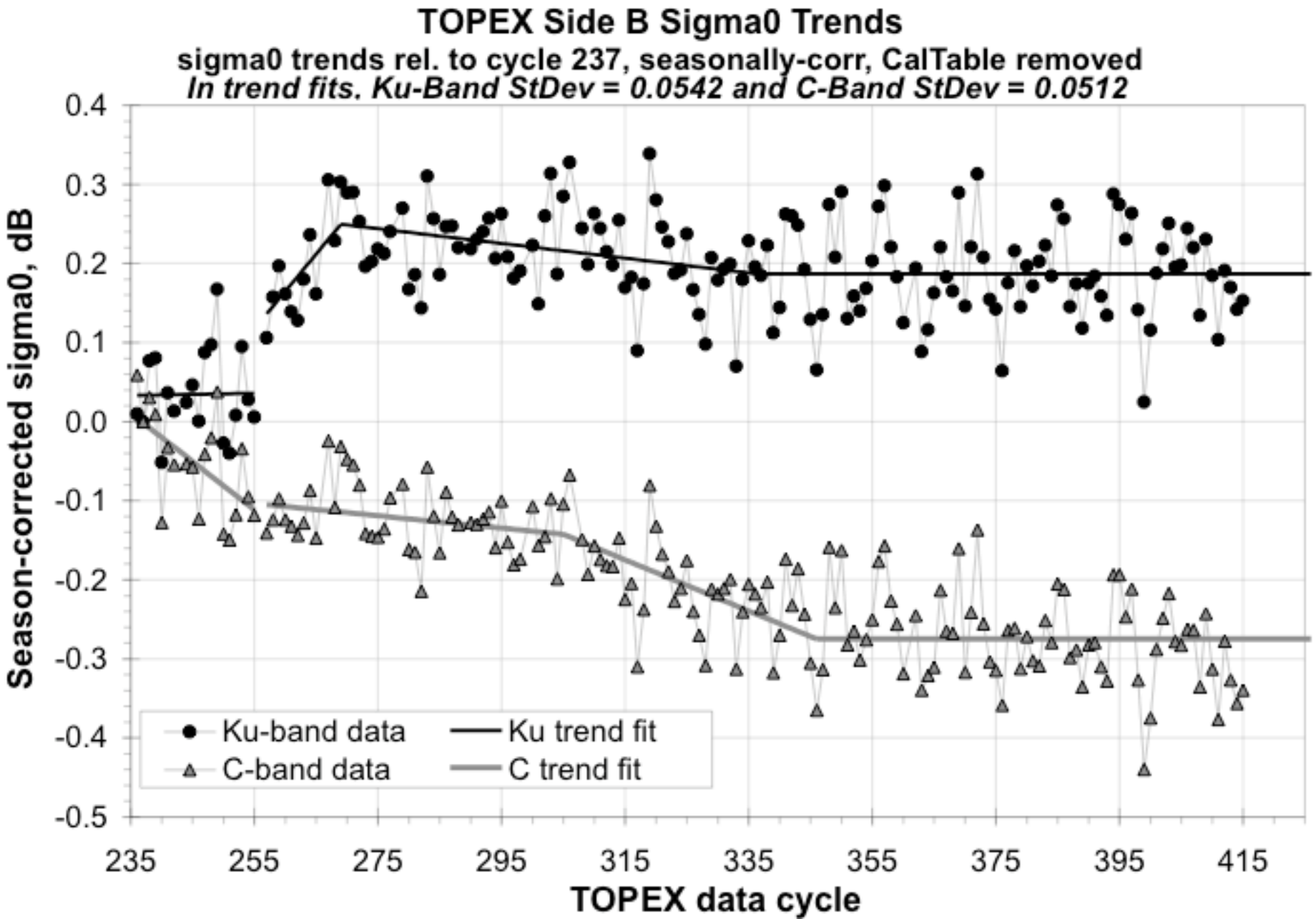

TOPEX Side B Ku-Band Cal Sweep 2003 Day 364
Ku-band Cal Sweep, dB
0
-5
-10
-15
-20
-25
-30
-35
-6
-5
-4
-3
-2
-1
0
1
2
3
4
5
6
Waveform Sample Units (1 unit = 3.125 ns)
K_sideB (2003d364t06:03)
Ku-band B_99d042
pure sinc^2

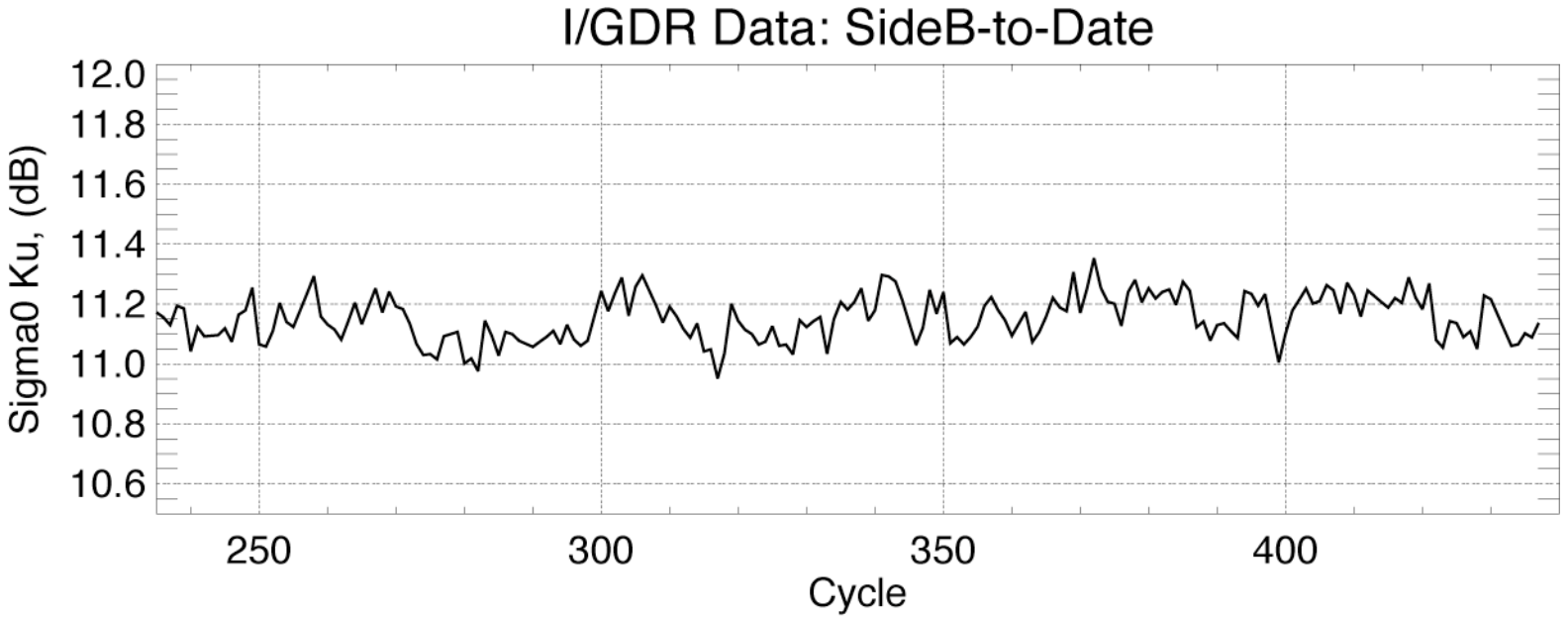

TOPEX Side B C-Band Cal Sweep 2003 Day 364
C-band Cal Sweep, dB
0
-5
-10
-15
-20
-25
-30
-35
-6
-5
-4
-3
-2
-1
0
1
2
3
4
5
6
Waveform Sample Units (1 unit = 3.125 ns)
C_sideB (2003d364t06:03)
C-band B_99d042
pure sinc^2

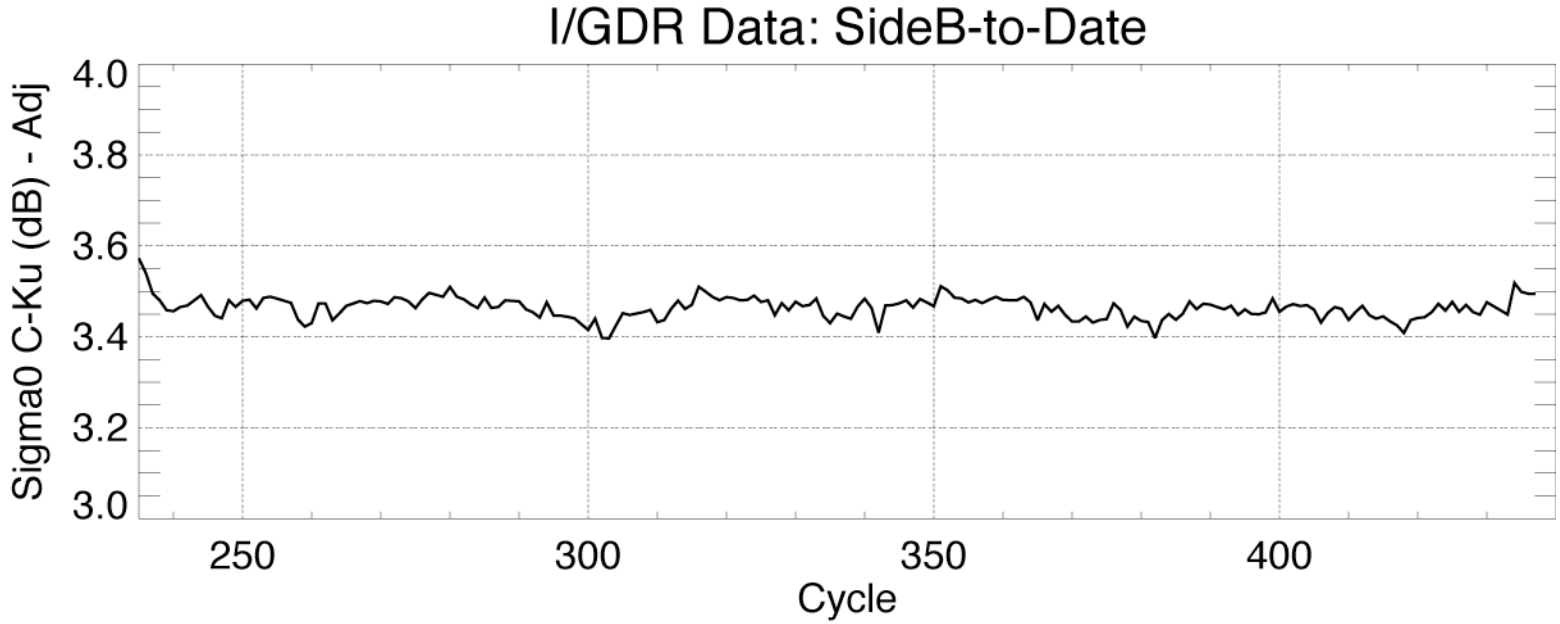


Significant Events Since Last Workshop

- 2003/310 — Reloaded memory to rectify science memory corruption
  - Lost 0.72 hours of data
- 2004/147-164 — Spacecraft in safehold mode due to a roll reaction wheel failure
  - Reloaded memory
  - Lost 16 days, 8 hours, of data
- 2004/178-207 — Data quality impacted by large attitude angles
  - OBC s/w patch for momentum bias inserted on Day 2004208
  - Attitude control within specifications since insertion of the patch


TOPEX Side B Sigma0 Trends
sigma0 trends rel. to cycle 237, seasonally-corr, CalTable removed
In trend fits. Ku-Band StDev = 0.0542 and C-Band StDev = 0.0512
Season-corrected sigma0, dB
0.4
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.4
-0.5
235
255
275
295
315
335
355
375
395
415
TOPEX data cycle
Ku-band data
C-band data
Ku trend fit
C trend fit





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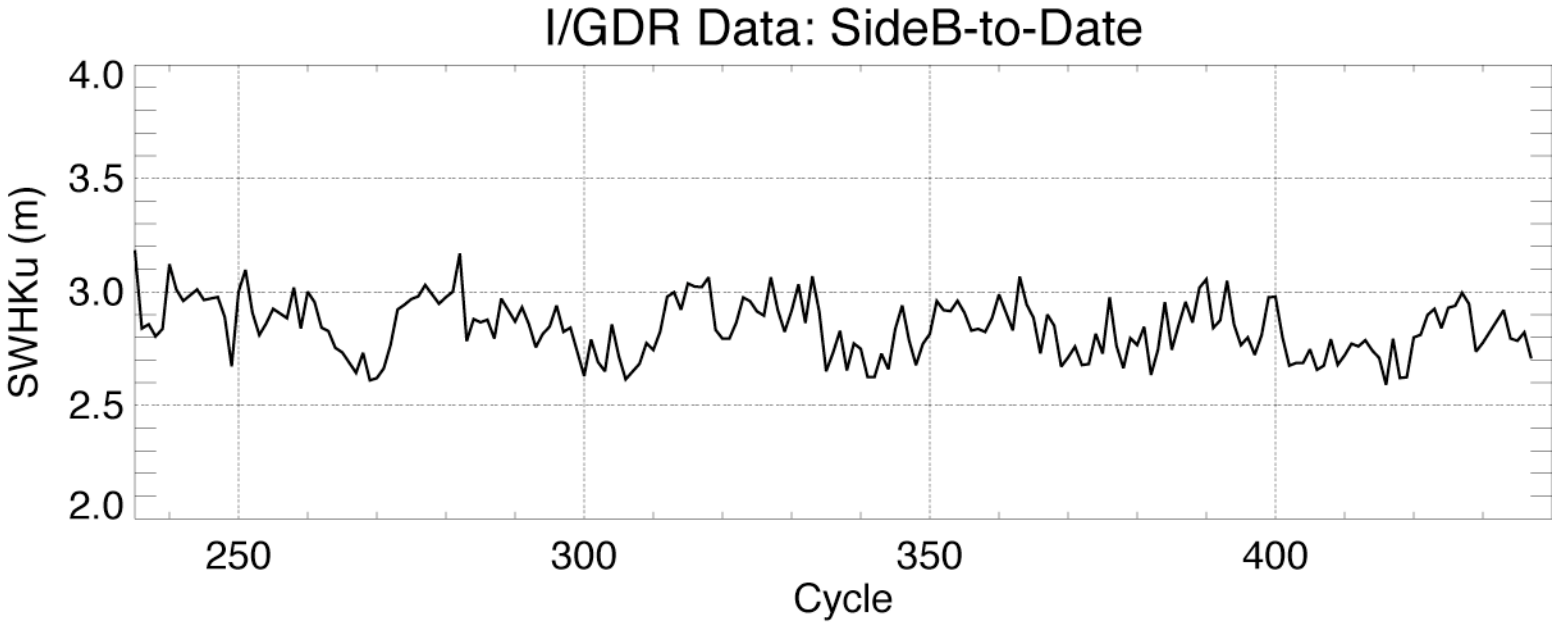

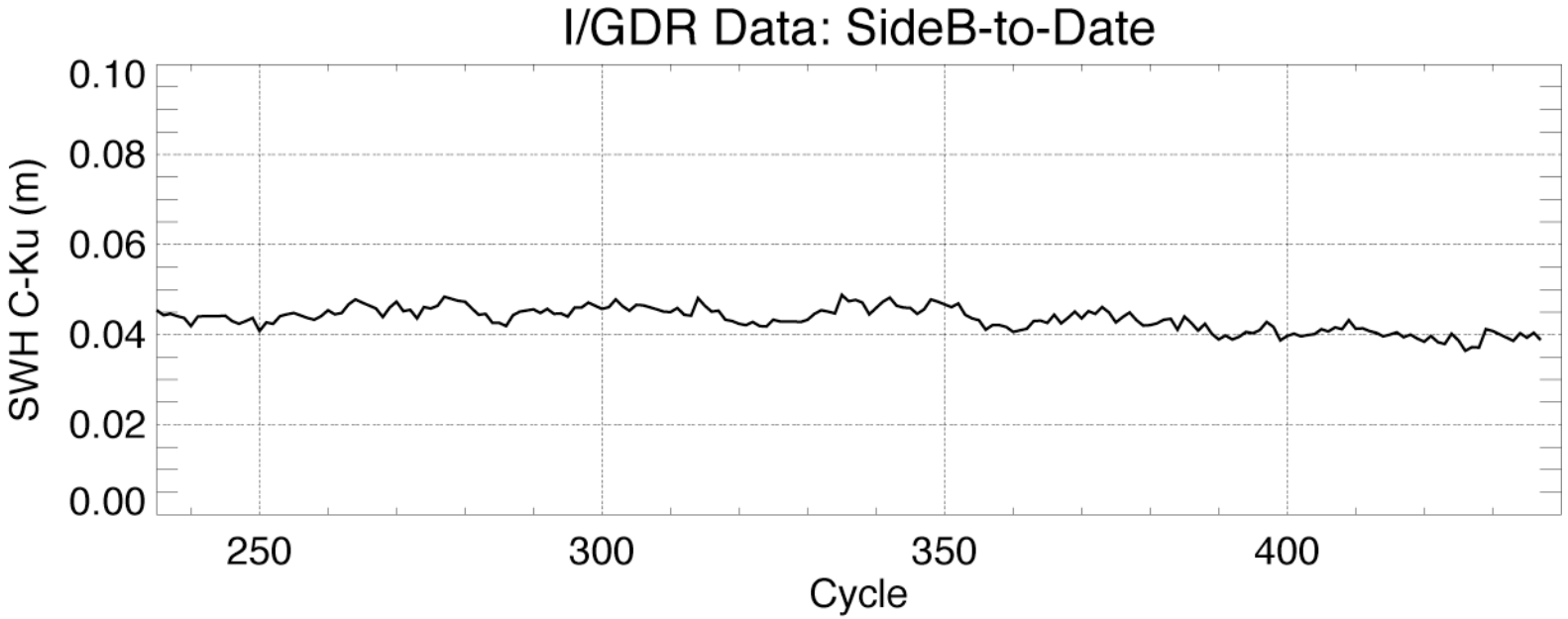

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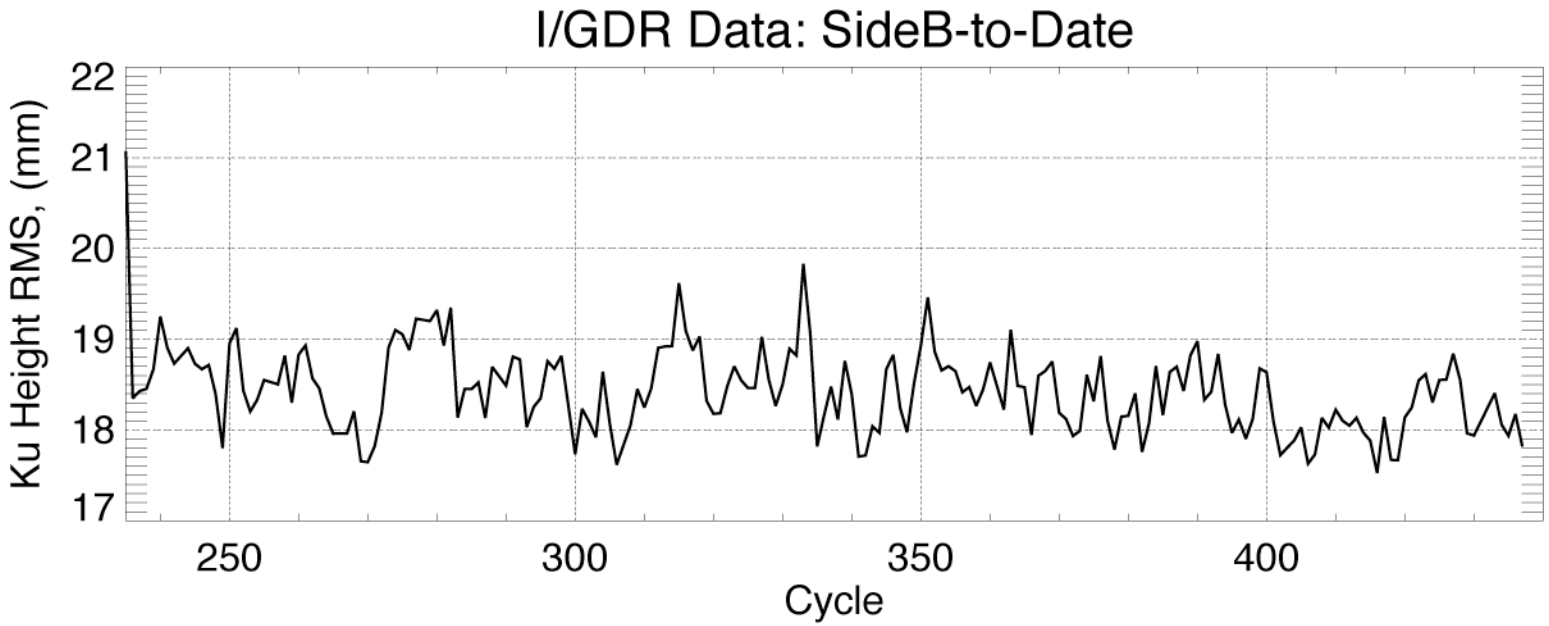

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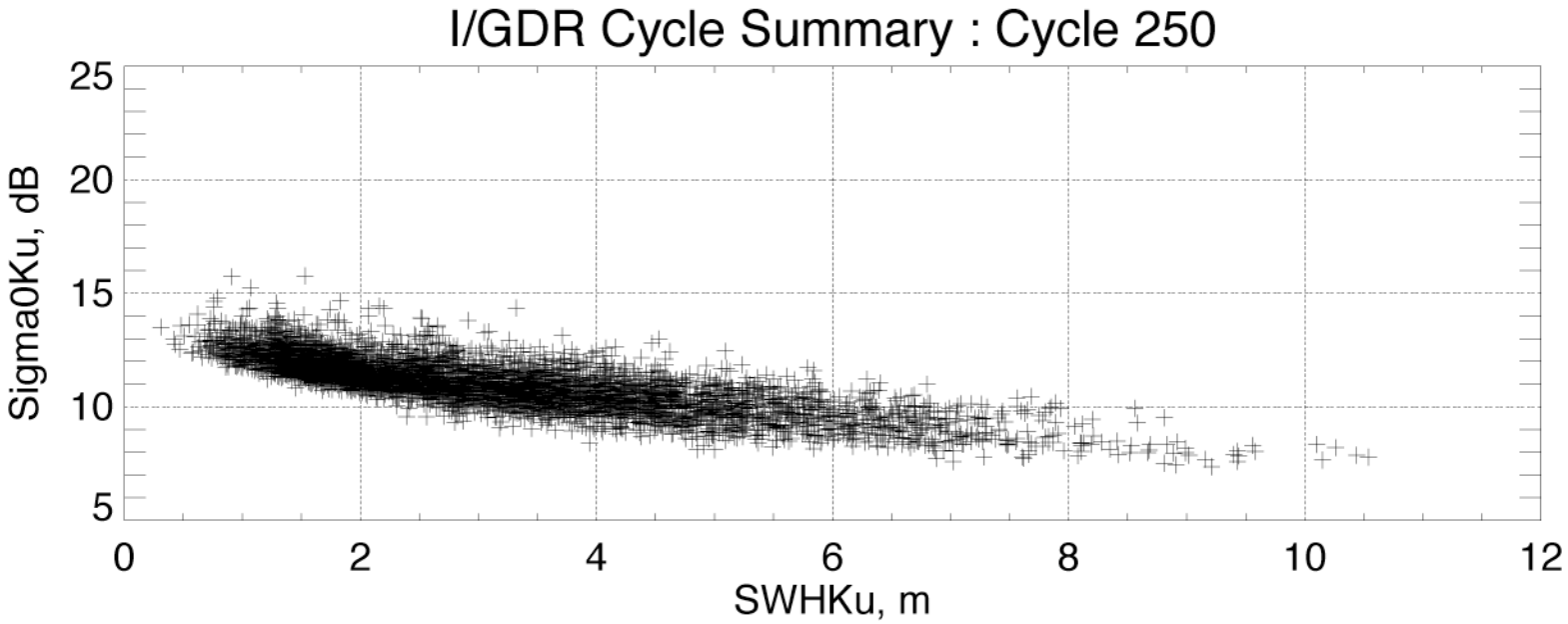

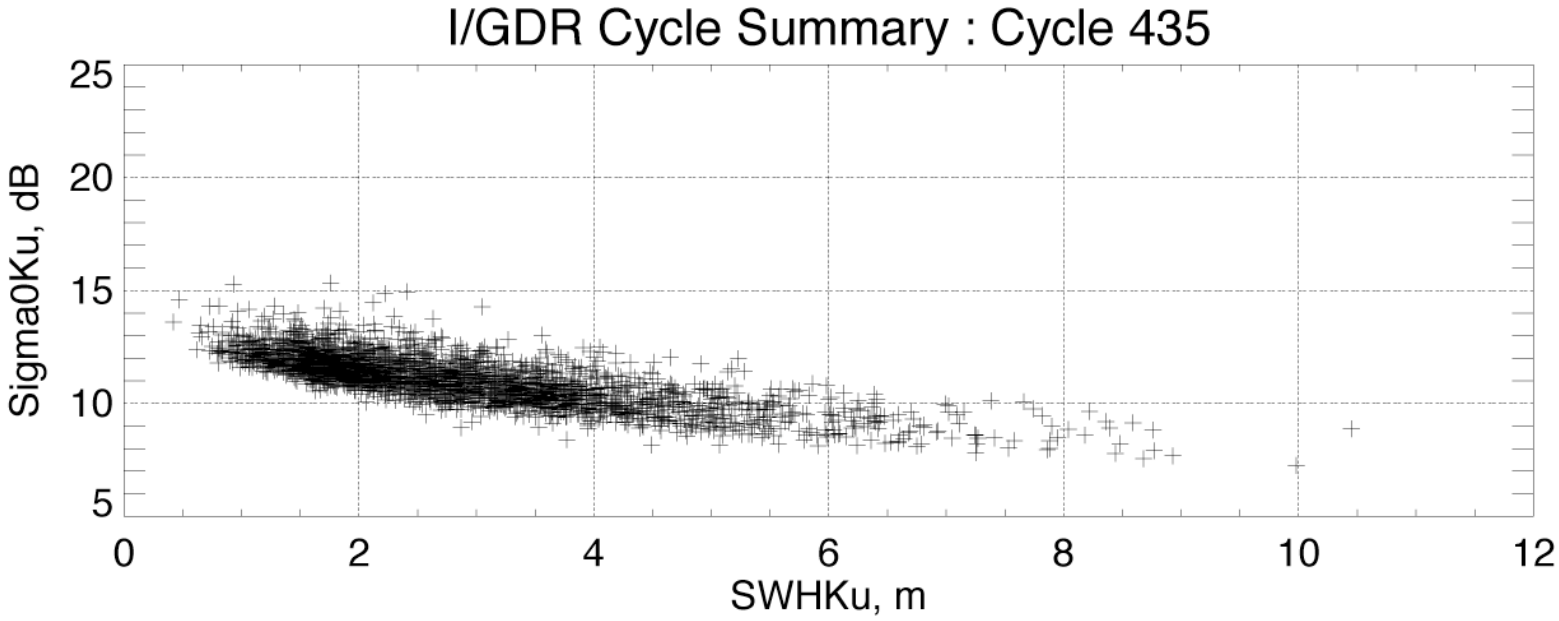

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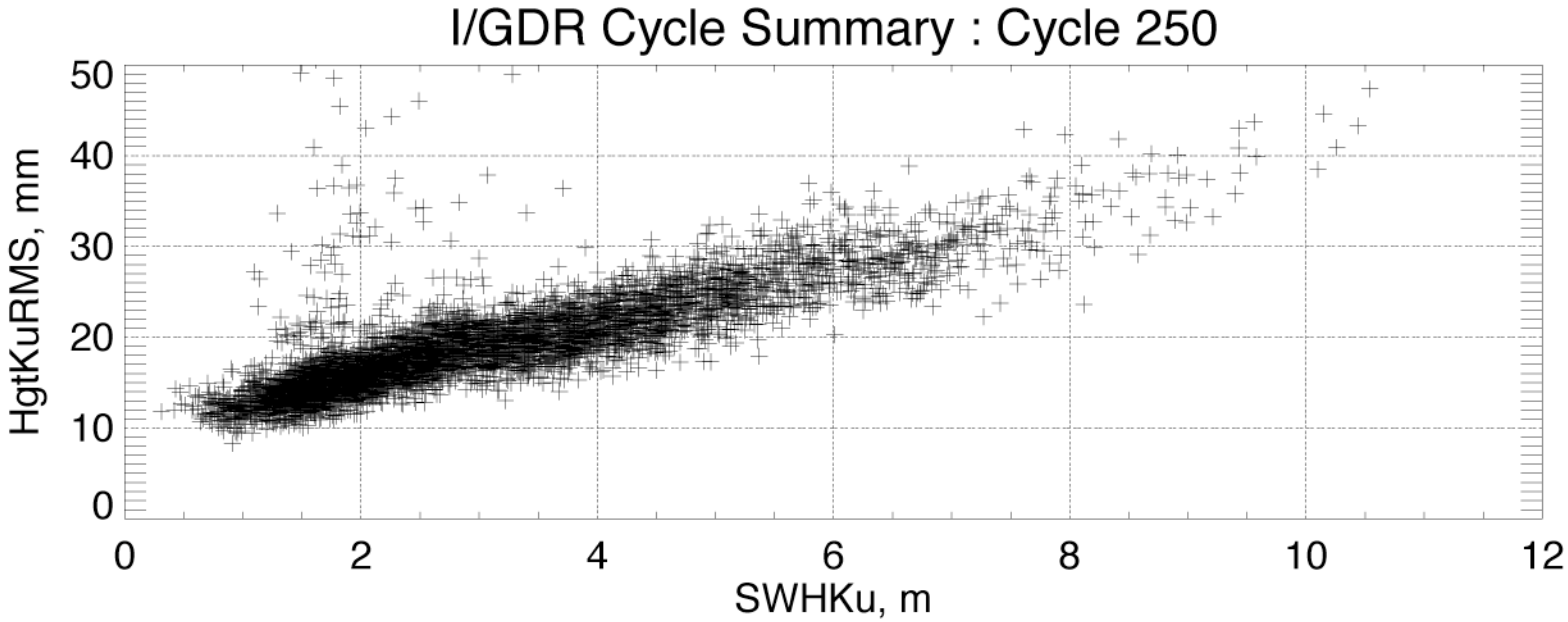

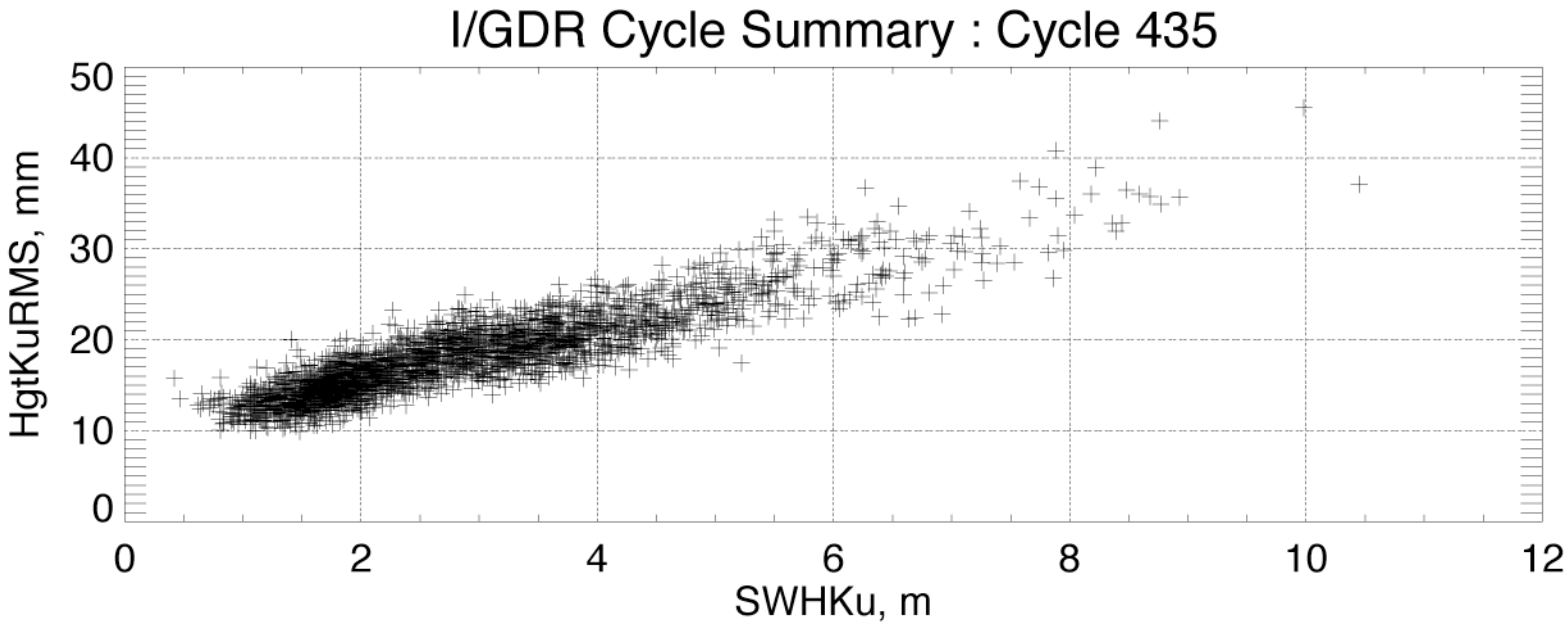

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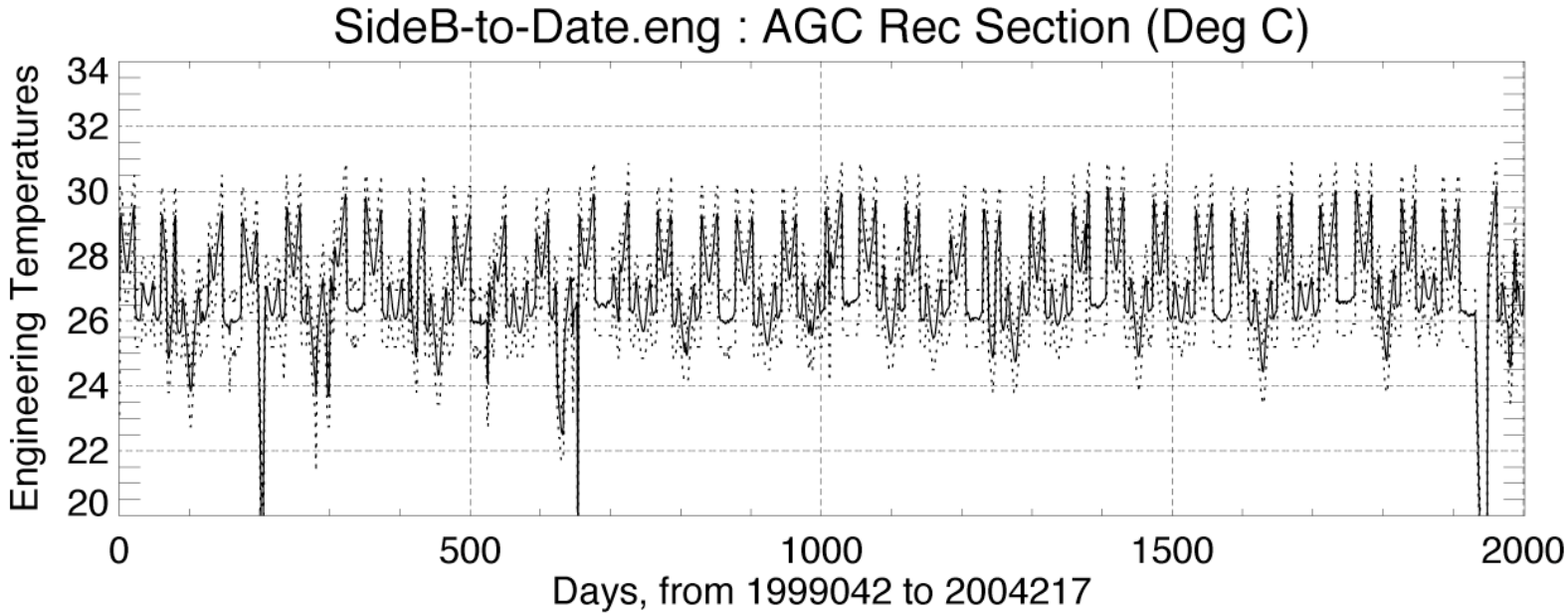

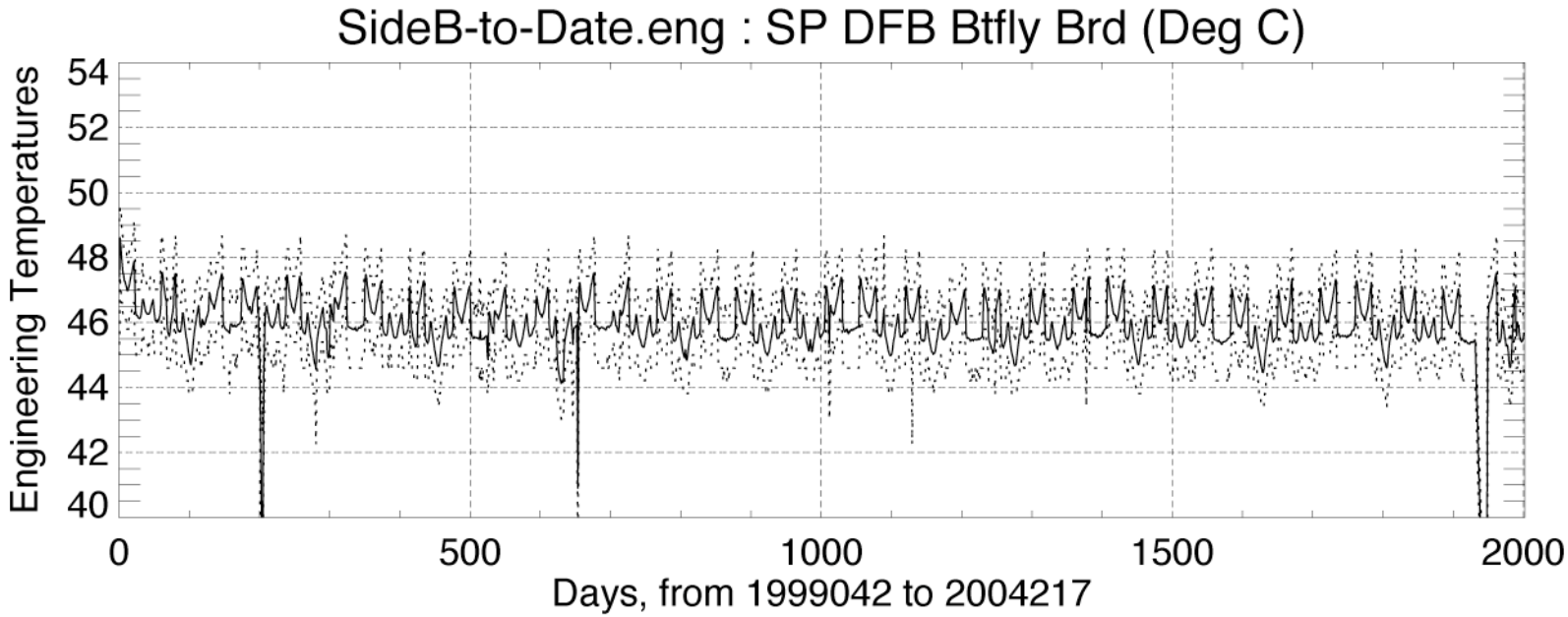

(24-Hour Averages)

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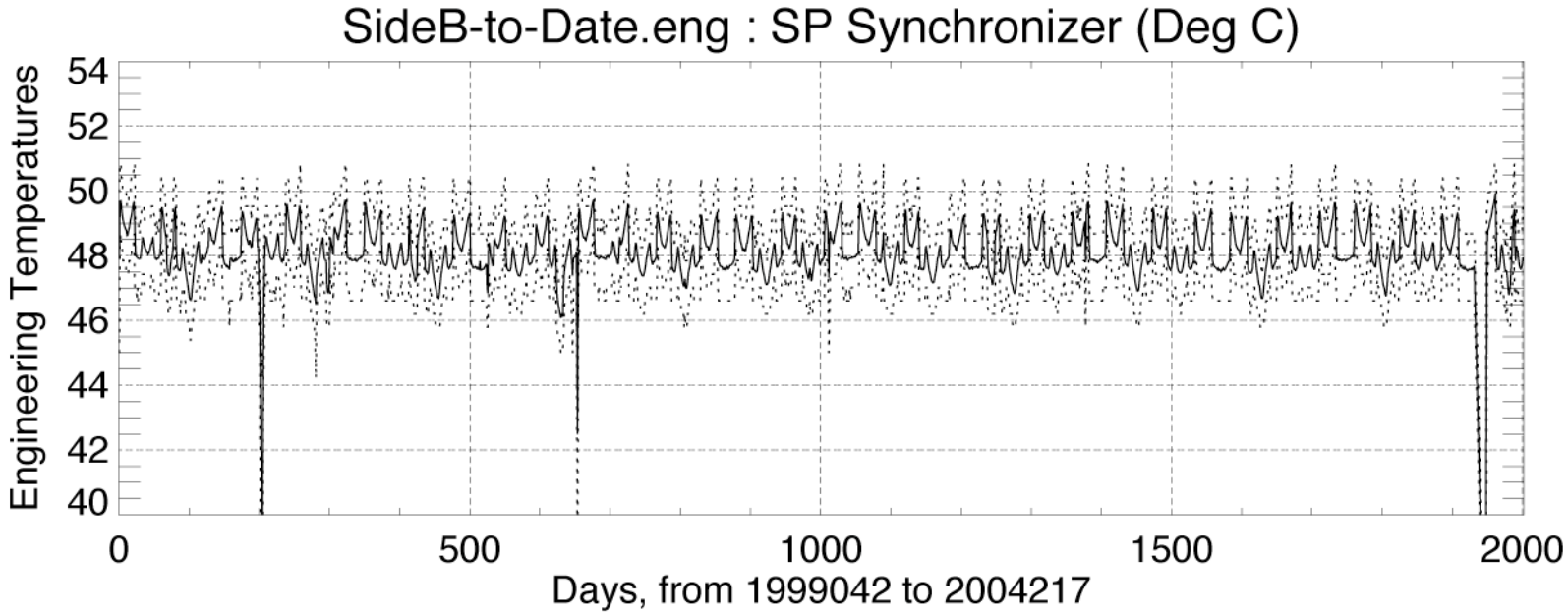

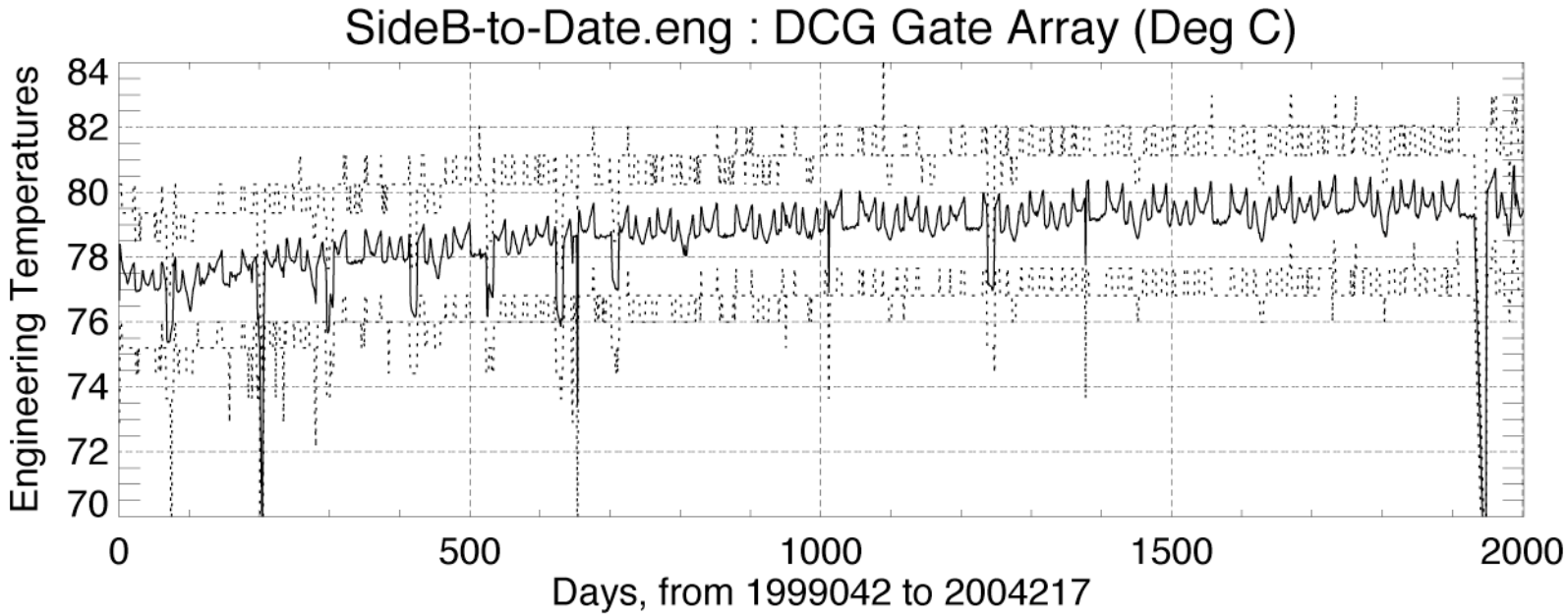

(24-Hour Averages)

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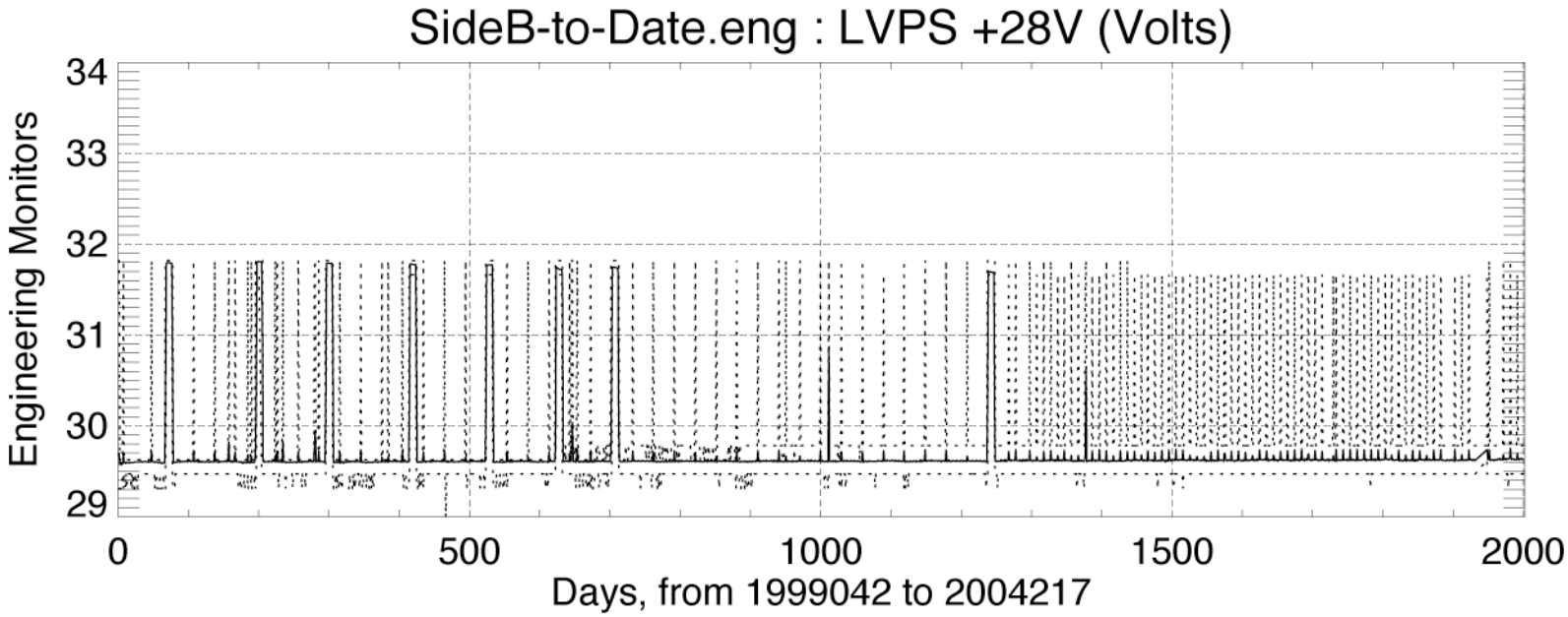

(24-Hour Averages)

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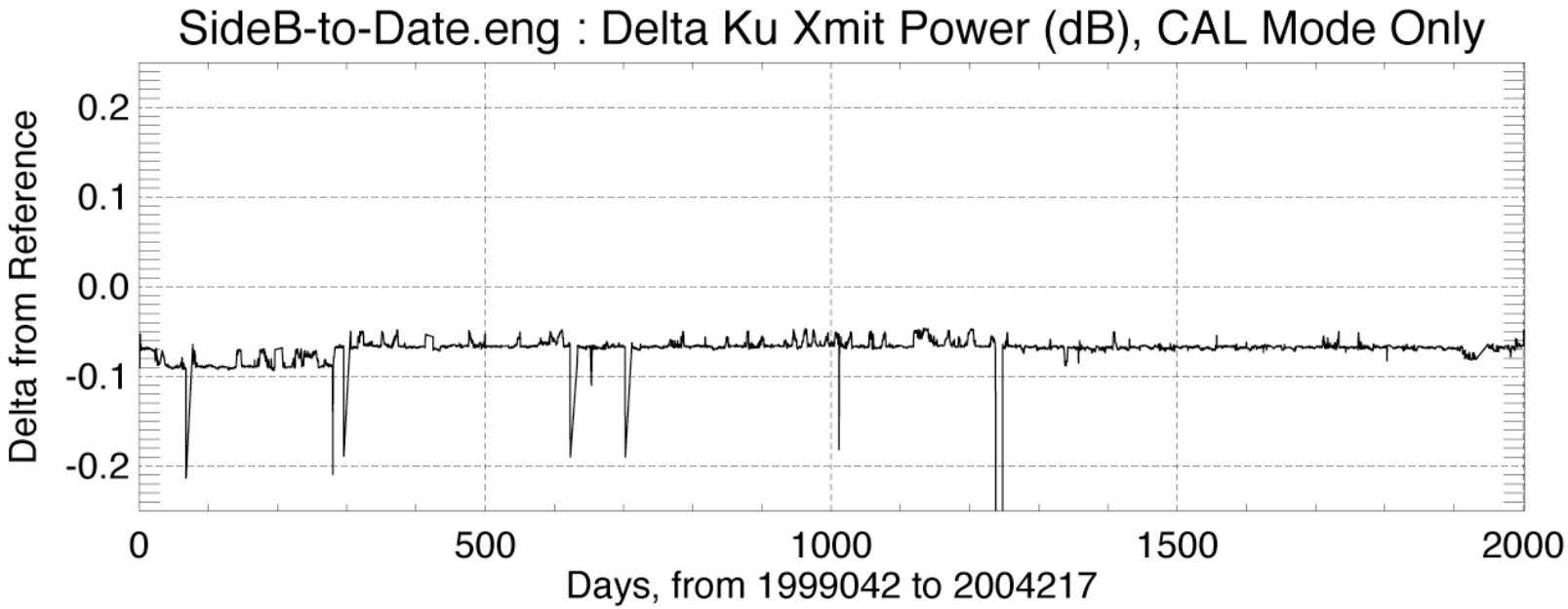

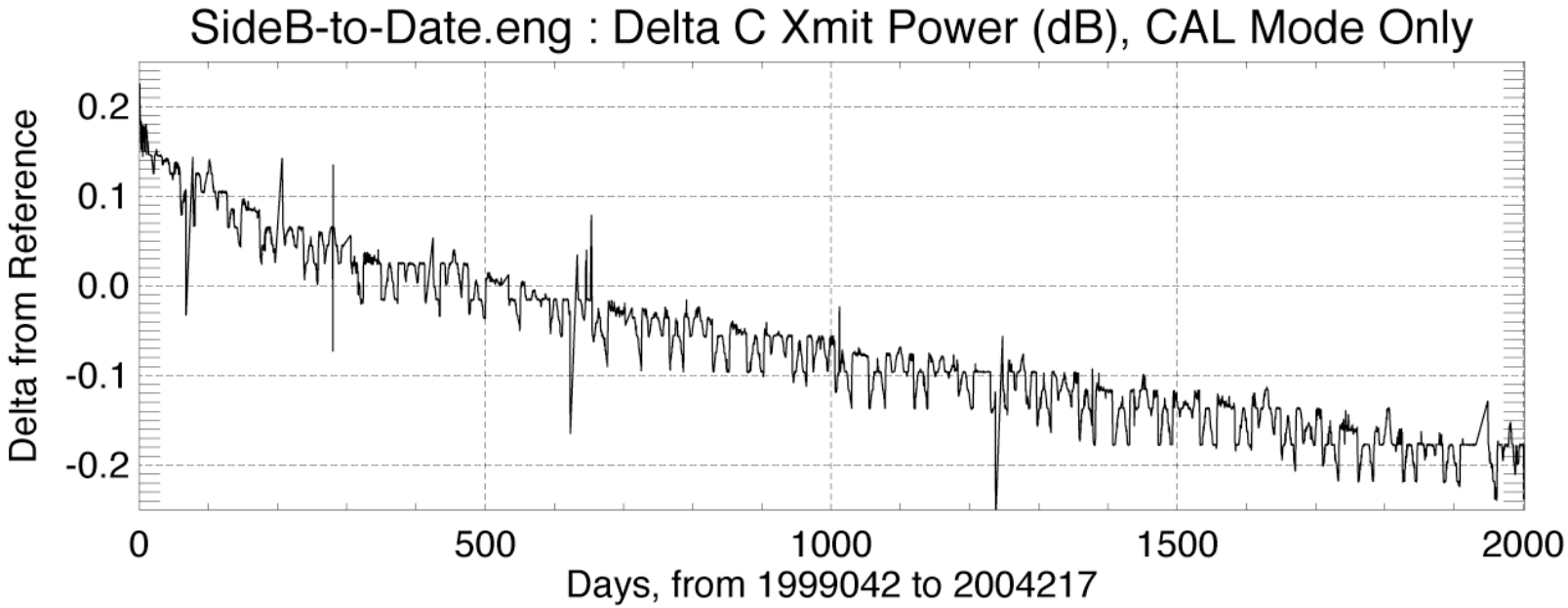

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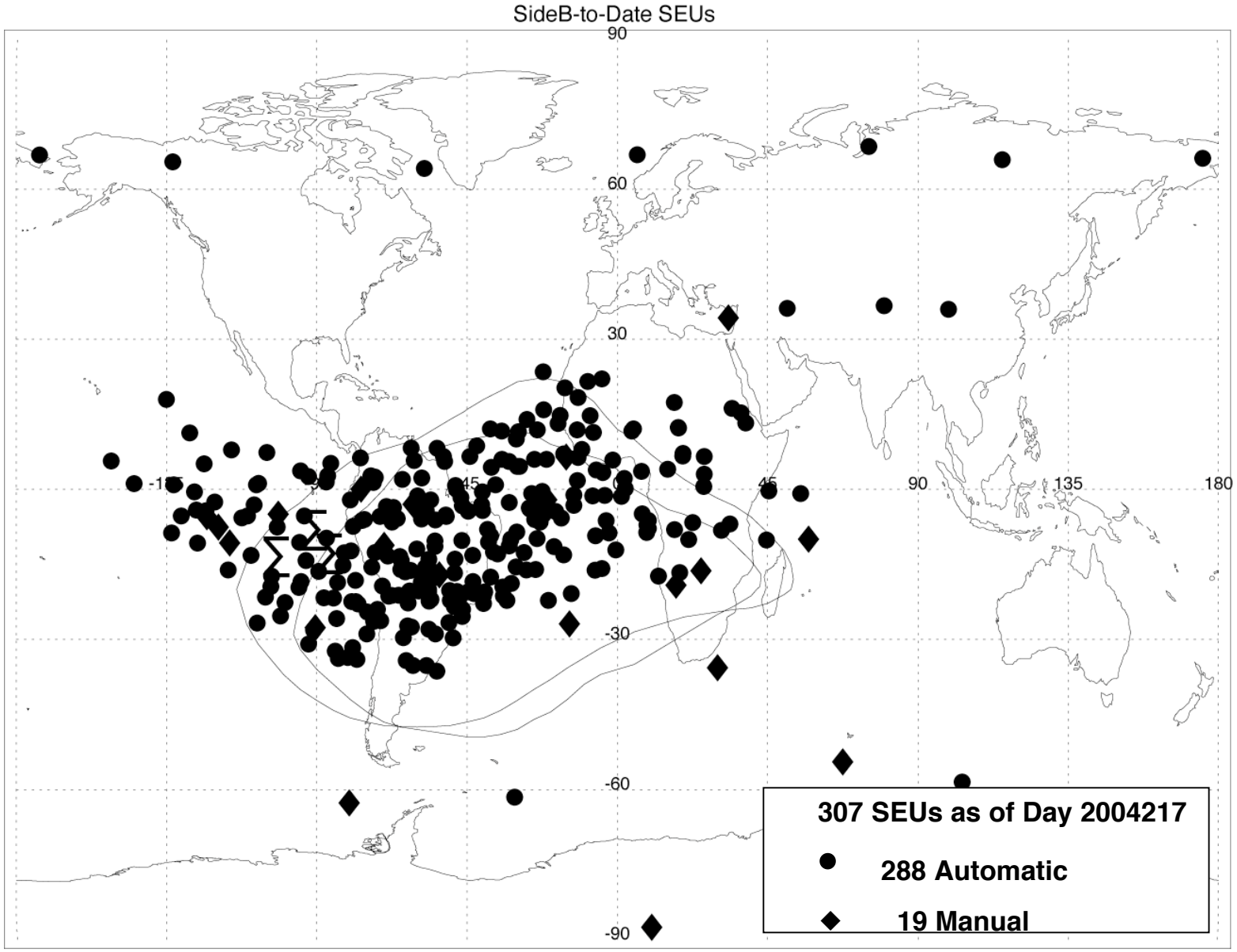

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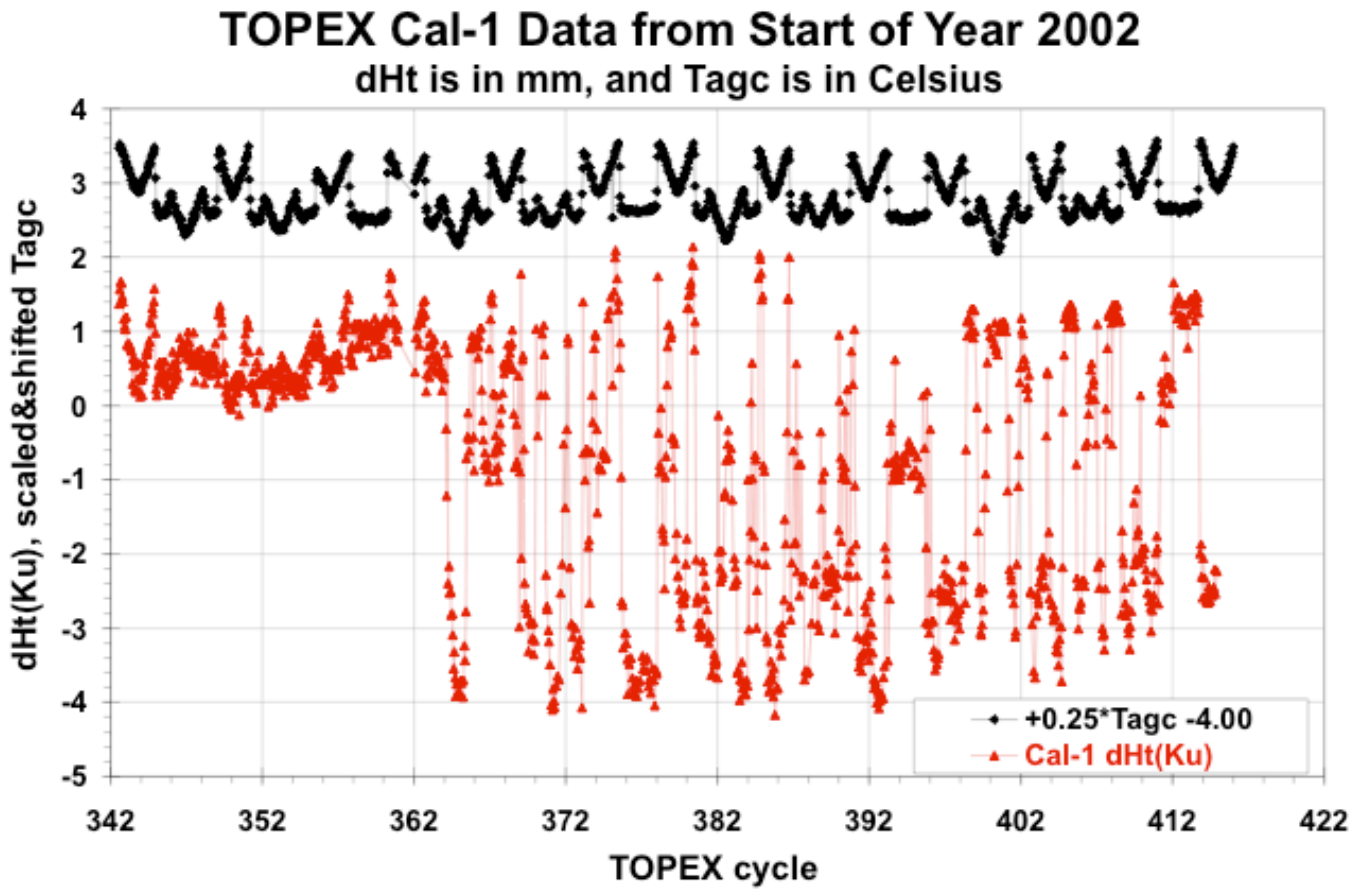

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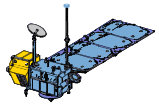
Concerns

Concerns from Earlier Workshops

- Side B DCG Gate Array Temperature
  - Temperature was rising approximately 1°/year but has since stabilized. Thermal analysis indicates no concern.
- Land-to-Water Acquisitions (Side B)
  - WFF regularly monitors the land-to-water acquisition times.
  - Several slow acquisitions observed since last workshop. Small impact on data, and not a significant concern. Will continue to monitor.
- Side B Ku-Band Calibration Mode Range Drift beginning at Cycle 364
  - Investigation shows toggling at resolution level.
  - Continue monitoring, no longer a concern.

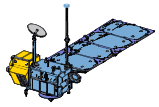


Concerns
(continued)

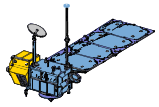
- Side B C-Band Transmit Power Decay Rate
  - Side B decay rate faster than Side A.
  - Known design performance, no action required.
  - Not seen as a large concern, will continue monitoring.

New Concern

- None for the TOPEX altimeter



BACK-UP SLIDES



NASA Altimeter Side B - Key Events	
Day	**Event**
1999/041	Commanded Side B to IDLE Mode and Uploaded Memory Patches
1999/042	Commanded Side B to STANDBY and then to TRACK Mode
1999/042	Side B Testing, including: Mode Checks, Cal-Sweep, and Waveform Leakage Tests
1999/043	Additional Testing, including: Cal-Sweep, Waveform Leakage Tests, and Gate-Shift Tests
1999/048	Gate Shift Tests (lost 3.1 hours of data)
1999/049	Cal-Sweep Test (lost 0.4 hours of overland data)
1999/049-050	Off-Nadir Tests
1999/050	Began First Side B Operational Cycle [Cycle 237]
1999/071	Improper SEU Recovery (lost 0.7 hours of data)
1999/089	Cal-Sweep Test (lost 0.4 hours of overland data)
1999/109	Cal-Sweep Test (lost 0.4 hours of overland data)
1999/109	Changed to IDLE Mode for SSALT
1999/119	Returned to TRACK Mode
1999/119	Cal-Sweep Test (lost 0.4 hours of overland data)
1999/149	Cal-Sweep Test (lost 0.4 hours of overland data)
1999/179	Cal-Sweep Test (lost 0.4 hours of overland data)
1999/198-199	C-Band Autonomously Switched to Side A Transmit (lost 5.6 hours of data)
1999/209	Cal-Sweep Test (lost 0.4 hours of overland data)
1999/223	C-Band CAMPIN Autonomously Disabled (lost 1.6 hours of data). Some corruption of Non-Protected Memory
1999/226	Unsuccessful Restoration of Non-Protected Memory, due to Command Table Error (lost 0.6 hours of overland data)
1999/231	Successful Restoration of Non-Protected Memory (lost 1.1 hours of mostly overland data)
1999/236	Commanding for New Parameter File, to Increase AGC Minimum from 13 to 15 dB (lost 0.1 hours of overland data).

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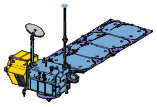
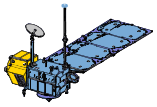
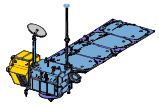
NASA Altimeter Side B - Key Events	
Day	**Event**
1999/237	Cal-Sweep Test (lost 0.4 hours of overland data)
1999/238	Changed to IDLE Mode for SSALT
1999/243	Spacecraft Safehold, after a reset of central data processing unit. ALT was automatically turned OFF.
1999/243	Commanded ALT back to IDLE Mode. Total OFF time was 15.7 hours.
1999/244	Uploaded full memory dump command. ALT remains in IDLE.
1999/245	ALT turned OFF during Attitude Control Electronics switchover
1999/246	Commanded ALT back to IDLE Mode and Uploaded full memory dump command. ALT remains in IDLE. OFF time was 7.9 hours.
1999/248	Returned to TRACK Mode
1999/252	Digital Filter Bank Calibration (lost 0.3 hours of overland data)
1999/265	Sent Commands in Attempt to Improve Acquisition. Lost 1.1 hours of land and ocean data. Commanding was Unsuccessful.
1999/268	Cal-Sweep Test (lost 0.4 hours of overland data)
1999/276	Ku-Band Autonomously Switched to Side A Transmit (lost 3.1 hours of data)
1999/298	Cal-Sweep Test (lost 0.4 hours of overland data)
1999/327	Cal-Sweep Test (lost 0.4 hours of overland data)
1999/337	Changed to IDLE Mode for SSALT
1999/347	Returned to TRACK Mode
1999/357	Cal-Sweep Test (lost 0.4 hours of overland data)
1999/360	SEU resulted in corruption of the engineering Pass Count value. No apparent effect on ALT science data.
2000/012	Orbital Maneuver #13 (affected 1.2 hours of data)
2000/022	Cal-Sweep Test (lost 0.4 hours of overland data)
2000/036	Digital Filter Bank Calibration (lost 0.3 hours of overland data)



NASA Altimeter Side B – Key Events	
Day	**Event**
2000/052	Cal-Sweep Test (lost 0.4 hours of overland data)
2000/056-061	SEU at 056/141130 UTC resulted in corrupted engineering spare word. Memory reload on 061/070828 UTC corrected problem. ALT science data quality during the interim was apparently not affected.
2000/061	Reloaded memory to rectify engineering memory corruption which began on day 056. Lost 0.9 hours of mostly overland data. This memory reload also restored the engineering Pass Count value which had been corrupted by an earlier SEU on 1999/360.
2000/067	Improper SEU recover (lost 5.8 hours of data)
2000/081	Cal-Sweep Test (lost 0.4 hours of overland data)
2000/091	Changed to IDLE Mode for SSALT
2000/101	Returned to TRACK Mode
2000/111	Cal-Sweep Test (lost 0.4 hours of overland data)
2000/141	Cal-Sweep Test (lost 0.4 hours of overland data)
2000/157	Improper SEU recovery (lost 1.9 hours of data)
2000/171	Cal-Sweep Test (lost 0.4 hours of overland data)
2000/200	Cal-Sweep Test (lost 0.4 hours of overland data)
2000/200	Changed to IDLE Mode for SSALT
2000/210	Returned to TRACK Mode
2000/227	Improper SEU recovery (lost 1.4 hours of data)
2000/230	Cal-Sweep Test (lost 0.4 hours of overland data)
2000/260	Cal-Sweep Test (lost 0.4 hours of overland data)
2000/275	Improper SEU recovery (lost 1.1 hours of data)
2000/290	Cal-Sweep Test (lost 0.4 hours of overland data)
2000/299	Changed to IDLE Mode for SSALT
2000/309	Returned to TRACK Mode



NASA Altimeter Side B – Key Events	
Day	**Event**
2000/319	Cal-Sweep Test (lost 0.4 hours of overland data)
2000/322	Changed to IDLE Mode for Leonid Meteor Shower (lost 2.0 hours of data)
2000/329	Spacecraft Safehold, ALT was automatically turned OFF due to bad ephemeris load.
2000/330	Commanded Alt back to Track. Total off time was 27.1 hours.
2000/349	Cal-Sweep Test (lost 0.4 hours of overland data)
2000/352	Attitude Excursion to about 0.21 degrees for about 2000 seconds
2001/012	Cal-Sweep Test (lost 0.4 hours of overland data)
2001/013	Changed to IdeLE Mode for SSALT
2001/023	Returned to TRACK Mode
2001/036	The 'non-nominal' switch to Yaw Steering was caused by an OBC Euler-C Flag not being reset following the bad ephemeris load and Safehold of 11/23/00. (Flag was not reset due to an erroneous reinitialization command file). Lost 0.4 hours of data.
2001/043	Cal-Sweep Test (lost 0.4 hours of overland data)
2001/070	Improper SEU recovery (lost 0.02 hours of data)
2001/072	Cal-Sweep Test (lost 0.4 hours of overland data)
2001/079	Improper SEU recovery (lost 1.33 hours of data)
2001/101	Digital Filter-Bank Leakage Test and Transmit Test (lost 0.9 hours of data)
2001/102	Cal-Sweep Test (lost 0.4 hours of overland data)
2001/112	Improper SEU recovery (lost 1.30 hours of data)
2001/132	Cal-Sweep Test (lost 0.4 hours of overland data)
2001/162	Cal-Sweep Test (lost 0.4 hours of overland data)
2001/166	Improper SEU recovery (lost 0.01 hours of data)
2001/173-174	Improper SEU recovery (lost 3.23 hours of data)
2001/191	Cal-Sweep Test (lost 0.4 hours of overland data)
2001/205	Improper SEU recovery (lost 3.00 hours of data)



NASA Altimeter Side B – Key Events	
Day	Event
2001/217	Improper SEU recovery (lost 6.45 hours of data)
2001/221	Cal-Sweep Test (lost 0.4 hours of overland data)
2001/251	Cal-Sweep Test (lost 0.4 hours of overland data)
2001/258-261	SEU at 258/175123 UTC resulted in corrupted science spare word. Memory reload started on 261/035412 UTC corrected problem. ALT science data quality during the interim was apparently not affected.
2001/261	Reloaded memory to rectify science memory corruption which began on day 258. Lost 0.72 hours of mostly overland data.
2001/281	Cal-Sweep Test (lost 0.4 hours of overland data)
2001/310	Cal-Sweep Test (lost 0.4 hours of overland data)
2001/322	Changed to IDLE Mode for Leonid Meteor Shower (lost 17.0 hours of data)
2001/340	Cal-Sweep Test (lost 0.4 hours of overland data)
2002/005	Cal-Sweep Test (lost 0.4 hours of overland data)
2002/020	Failed Completion of Digital Filter-Bank Leakage Test (lost 1.8 hours of data)
2002/035	Cal-Sweep Test (lost 0.4 hours of overland data)
2002/064	Cal-Sweep Test (lost 0.4 hours of overland data)
2002/094	Cal-Sweep Test (lost 0.4 hours of overland data)
2002/124	Cal-Sweep Test (lost 0.4 hours of overland data)
2002/154	Cal-Sweep Test (lost 0.4 hours of overland data)
2002/183	Cal-Sweep Test (lost 0.4 hours of overland data)
2002/183	Changed to IDLE Mode for SSALT
2002/193	Returned to TRACK Mode
2002/213	Cal-Sweep Test (lost 0.4 hours of overland data)
2002/223	Cal-Sweep Test (lost 0.4 hours of overland data)
2002/227	Start TOPEX Orbit Transfer Maneuver (TOTM). TOTM-D227, Burn 1 of 6.

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NASA Altimeter Side B - Key Events	
Day	Event
2002/231	TOTM-D231, Burn 2 of 6.
2002/233	Cal-Sweep Test. ALT CAL-1 Sweep Test was unsuccessful due to data loss of 0.8 hours.
2002/235	TOTM-D235, Burn 3 of 6.
2002/243	Cal-Sweep Test (lost 0.4 hours of overland data)
2002/253	Cal-Sweep Test (lost 0.4 hours of overland data)
2002/253	TOTM-D253A & TOTM-D253B, Burn 4a & 4b of 6.
2002/256	TOTM-D256, Burn 5 of 6.
2002/259	Completed TOPEX Orbit Transfer Maneuver. TOTM-D259, Burn 6 of 6.
2002/263	Cal-Sweep Test (lost 0.4 hours of overland data)
2002/273	Cal-Sweep Test (lost 0.4 hours of overland data)
2002/283	Cal-Sweep Test (lost 0.4 hours of overland data)
2002/292	Cal-Sweep Test (lost 0.4 hours of overland data)
2002/302	Cal-Sweep Test (lost 0.4 hours of overland data)
2002/312	Cal-Sweep Test (lost 0.4 hours of overland data)
2002/322	Cal-Sweep Test (lost 0.4 hours of overland data)
2002/323	Changed to IDLE Mode for Leonid Meteor Shower (lost 13.0 hours of data)
2002/332	Cal-Sweep Test (lost 0.4 hours of overland data)
2002/342	Cal-Sweep Test (lost 0.4 hours of overland data). ALT CAL1 Sweep Test was invalidated by an [erroneously-scheduled] ALT Calibration command file.
2002/352	Cal-Sweep Test (lost 0.4 hours of overland data).
2002/362	Cal-Sweep Test (lost 0.4 hours of overland data).
2003/007	Cal-Sweep Test (lost 0.4 hours of overland data).
2003/017	Cal-Sweep Test (lost 0.4 hours of overland data).
2003/027	Cal-Sweep Test (lost 0.4 hours of overland data).
2003/037	Cal-Sweep Test (lost 0.4 hours of overland data).

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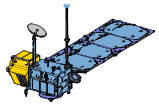
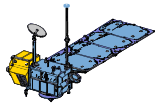


NASA Altimeter Side B - Key Events	
Day	Event
2003/046	Cal-Sweep Test (lost 0.4 hours of overland data).
2003/056	Cal-Sweep Test (lost 0.4 hours of overland data).
2003/066	Cal-Sweep Test (lost 0.4 hours of overland data).
2003/076	Cal-Sweep Test (lost 0.4 hours of overland data).
2003/086	Cal-Sweep Test (lost 0.4 hours of overland data).
2003/096	Cal Sweep Test (lost 0.4 hours of overland data).
2003/106	Cal Sweep Test (lost 0.4 hours of overland data).
2003/116	Cal Sweep Test (lost 0.4 hours of overland data).
2003/126	Cal Sweep Test (lost 0.4 hours of overland data).
2003/136	Cal Sweep Test (lost 0.4 hours of overland data).
2003/146	Cal Sweep Test (lost 0.4 hours of overland data).
2003/156	Cal Sweep Test (lost 0.4 hours of overland data).
2003/165	Cal Sweep Test (lost 0.4 hours of overland data).
2003/175	Cal Sweep Test (lost 0.4 hours of overland data).
2003/185	Cal Sweep Test (lost 0.4 hours of overland data).
2003/195	Cal Sweep Test (lost 0.4 hours of overland data).
2003/205	Cal Sweep Test (lost 0.4 hours of overland data).
2003/215	Cal Sweep Test (lost 0.4 hours of overland data).

NASA Altimeter Side B – Key Events Since Last Workshop	
Day	Event
2003/225	**Cal-Sweep Test (lost 0.4 hours of overland data).**
2003/235	**Cal-Sweep Test (lost 0.4 hours of overland data).**
2003/245	**Cal-Sweep Test (lost 0.4 hours of overland data).**
2003/255	**Cal-Sweep Test (lost 0.4 hours of overland data).**
2003/265	**Cal-Sweep Test (lost 0.4 hours of overland data).**
2003/275	**Cal-Sweep Test (lost 0.4 hours of overland data).**
2003/284	**Cal-Sweep Test (lost 0.4 hours of overland data).**
2003/294	**Cal-Sweep Test (lost 0.4 hours of overland data).**
2003/303-310	**SEU at 303/125511 UTC resulted in corrupted science spare word. Memory reload started on 310/022301 UTC corrected problem. ALT science data quality during the interim was apparently not affected.**
2003/310	**Reloaded memory to rectify science memory corruption which began on day 303. Lost 0.72 hours of mostly overland data.**
2003/314	**Cal-Sweep Test (lost 0.4 hours of overland data).**
2003/324	**Cal-Sweep Test (lost 0.4 hours of overland data).**
2003/334	**Cal-Sweep Test (lost 0.4 hours of overland data).**
2003/344	**Cal-Sweep Test (lost 0.4 hours of overland data).**
2003/354	**Cal-Sweep Test (lost 0.4 hours of overland data).**
2003/364	**Cal-Sweep Test (lost 0.4 hours of overland data).**
2004/009	**Cal-Sweep Test (lost 0.4 hours of overland data).**
2004/019	**Cal-Sweep Test (lost 0.4 hours of overland data).**
2004/028-029	**Cal-Sweep Test (lost 0.4 hours of overland data).**
2004/038	**Cal-Sweep Test (lost 0.4 hours of overland data).**
2004/048	**Cal-Sweep Test (lost 0.4 hours of overland data).**



NASA Altimeter Side B – Key Events Since Last Workshop	
Day	Event
2004/058	**Cal-Sweep Test (lost 0.4 hours of overland data).**
2004/068	**Cal-Sweep Test (lost 0.4 hours of overland data).**
2004/078	**Cal-Sweep Test (lost 0.4 hours of overland data).**
2004/088	**Cal-Sweep Test (lost 0.4 hours of overland data).**
2004/098	**Cal-Sweep Test (lost 0.4 hours of overland data).**
2004/108	**Cal-Sweep Test (no data available).**
2004118	**Cal-Sweep Test (lost 0.4 hours of overland data).**
2004128	**Cal-Sweep Test (lost 0.4 hours of overland data).**
2004138	**Cal-Sweep Test (lost 0.4 hours of overland data).**
2004/147	**Spacecraft in Safehold mode due to a roll reaction wheel failure.**
2004/164	**Commanded Alt back to Track. Total off time was 16 days, 7 hours, 52 minutes.**
2004167	**Cal-Sweep Test (lost 0.4 hours of overland data).**
2004177	**Cal-Sweep Test (lost 0.4 hours of overland data).**
2004187	**Cal-Sweep Test (lost 0.4 hours of overland data).**
2004197	**Cal-Sweep Test (lost 0.4 hours of overland data).**
2004207	**Cal-Sweep Test (lost 0.4 hours of overland data).**
2004217	**Cal-Sweep Test (lost 0.4 hours of overland data).**

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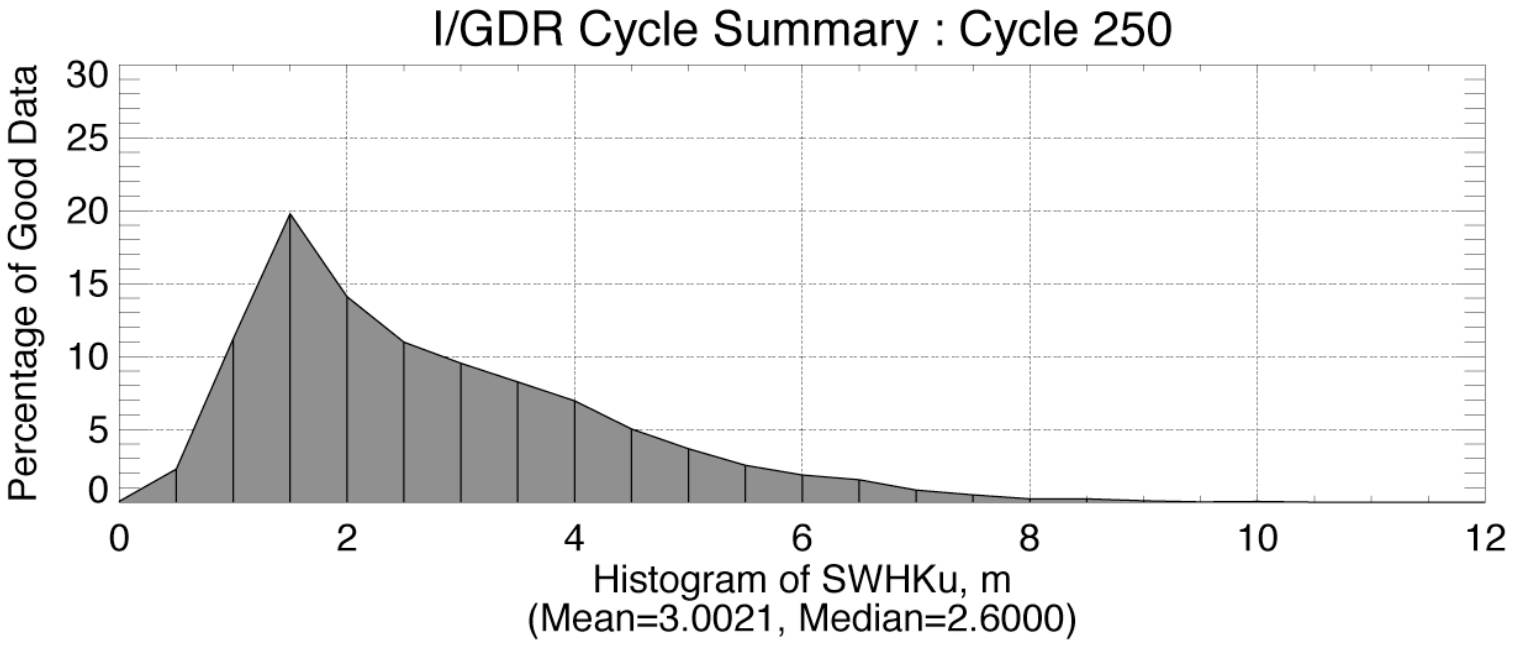

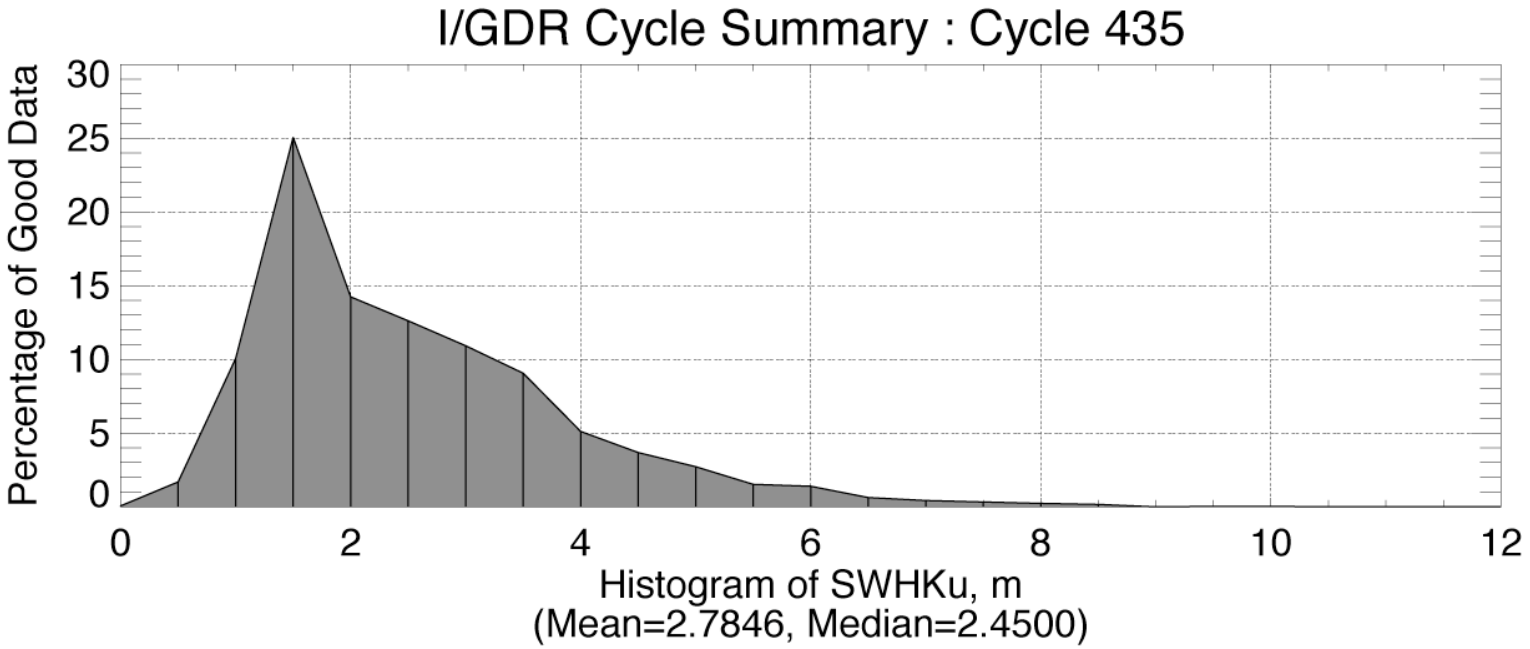

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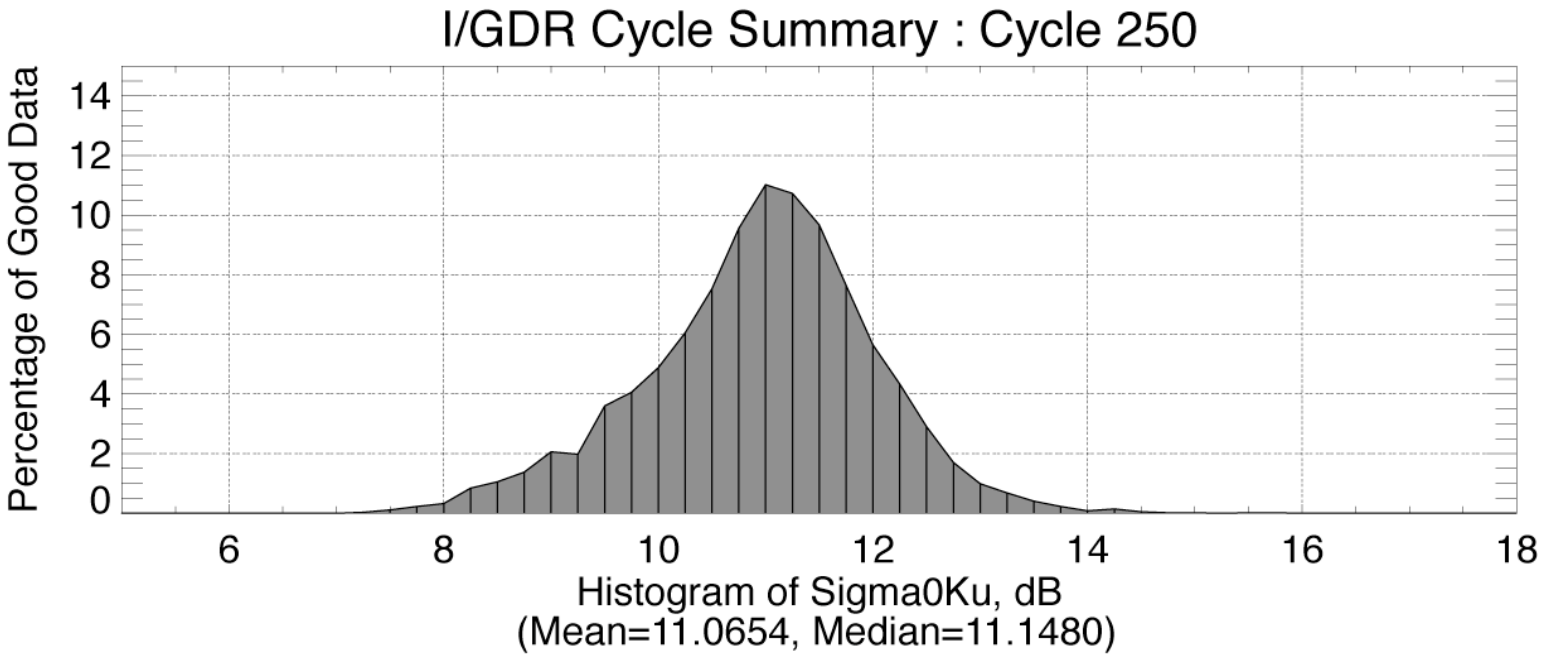

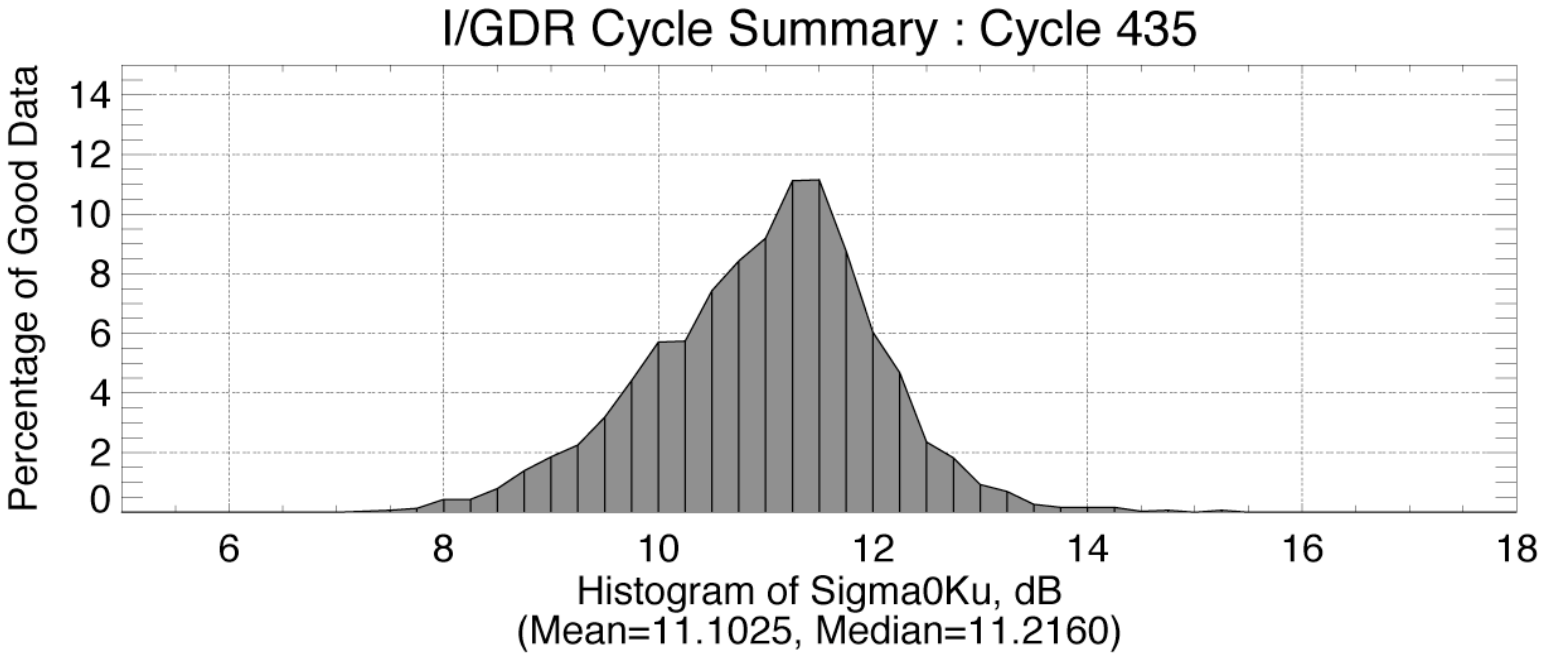

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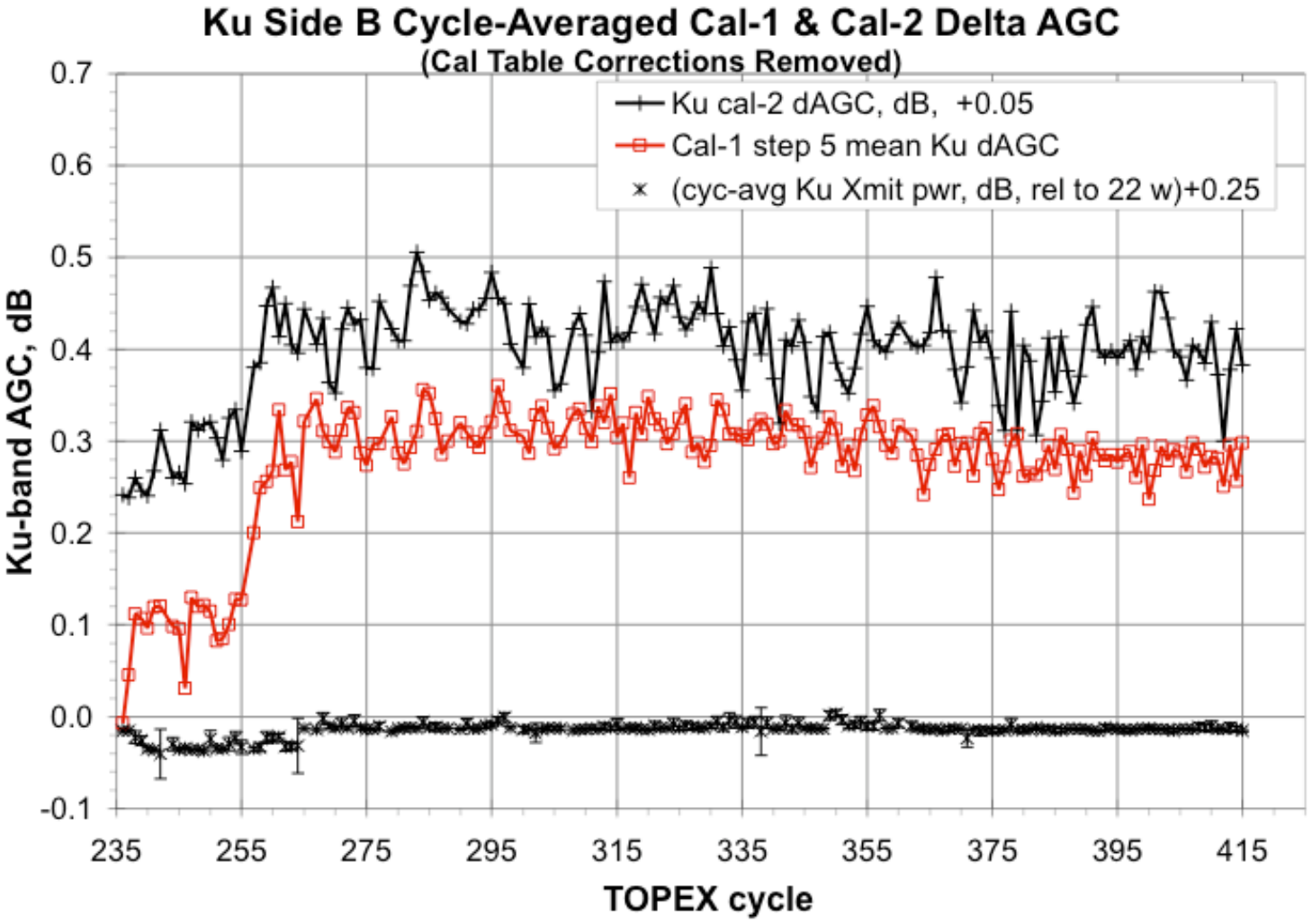

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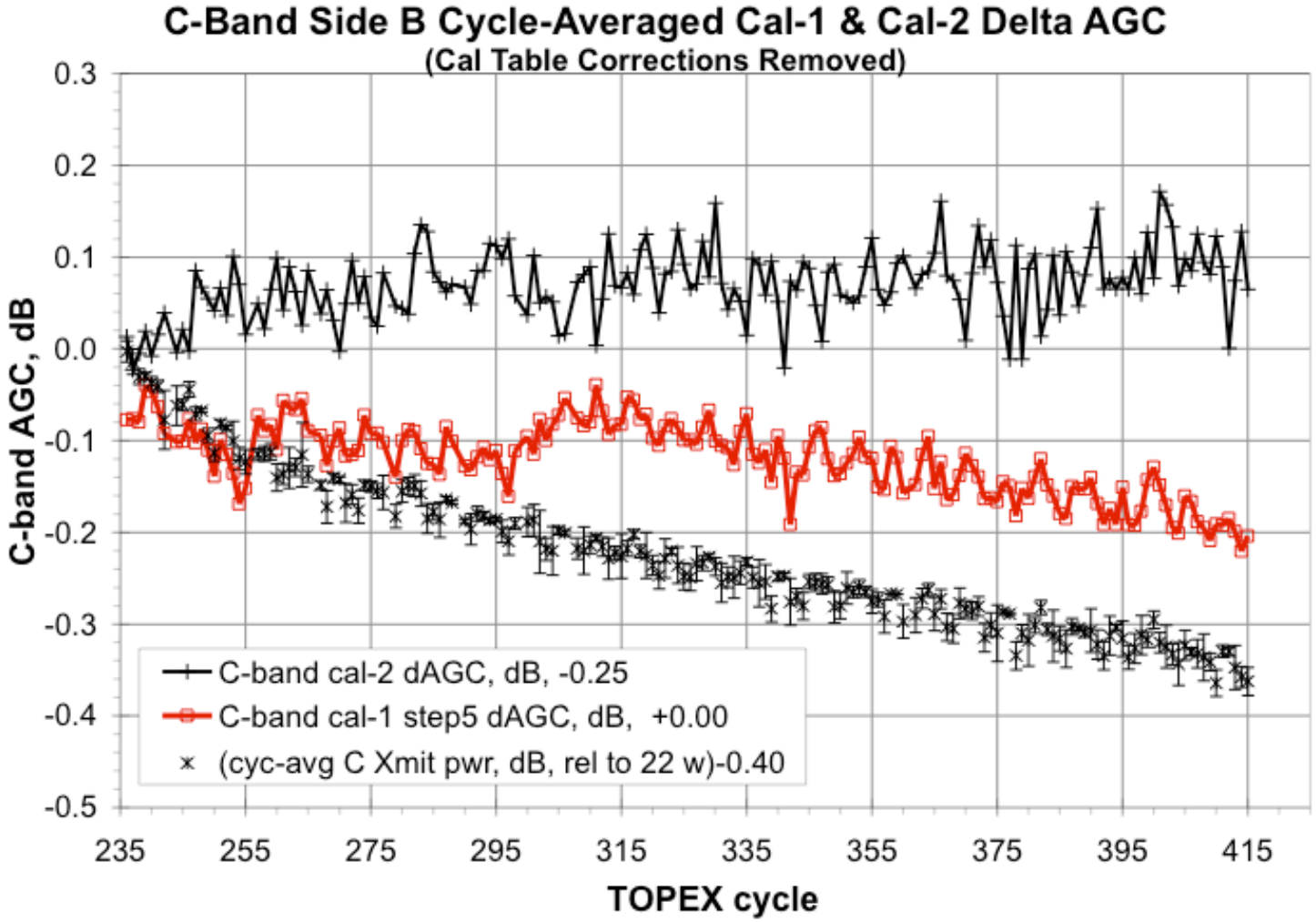

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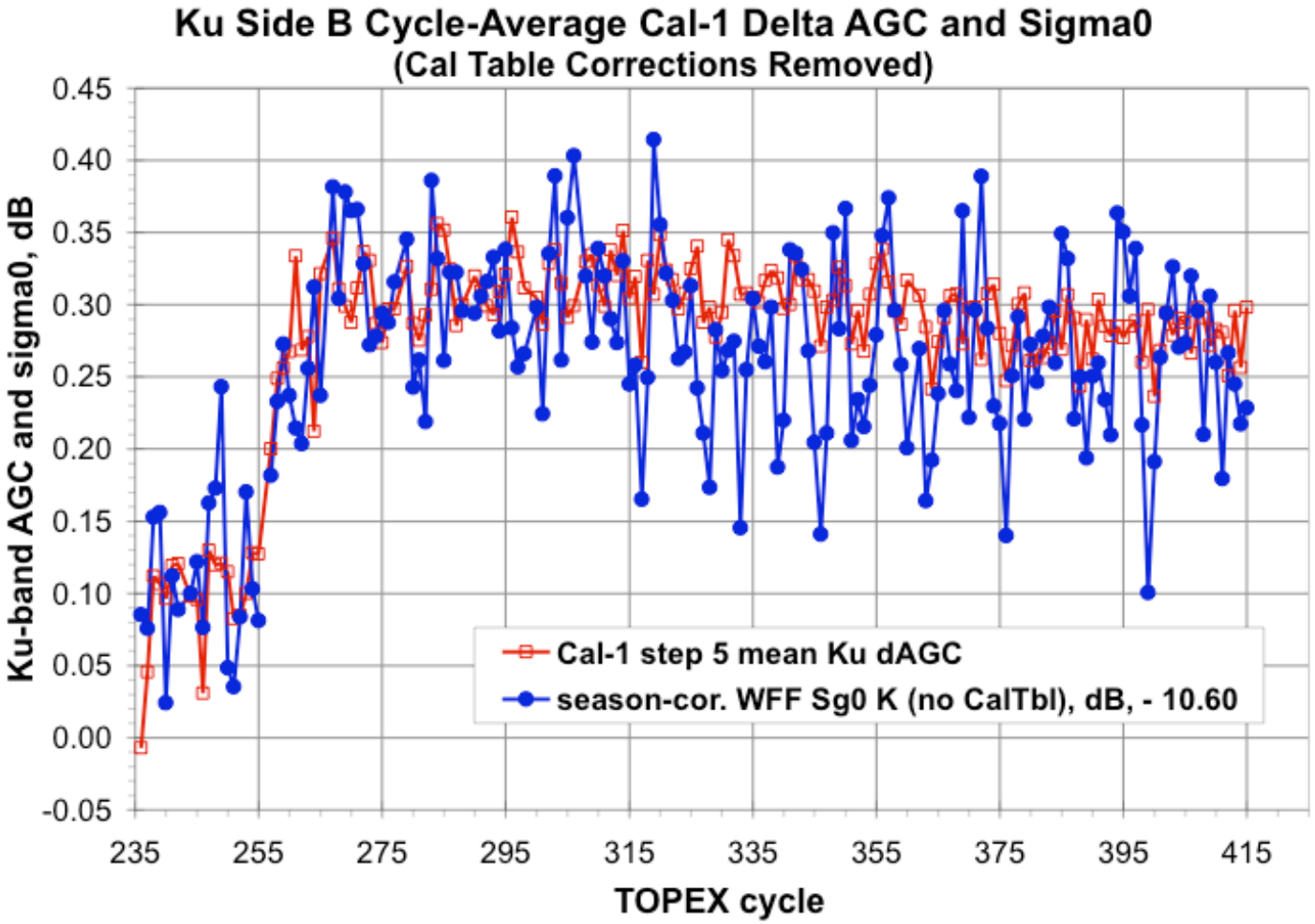

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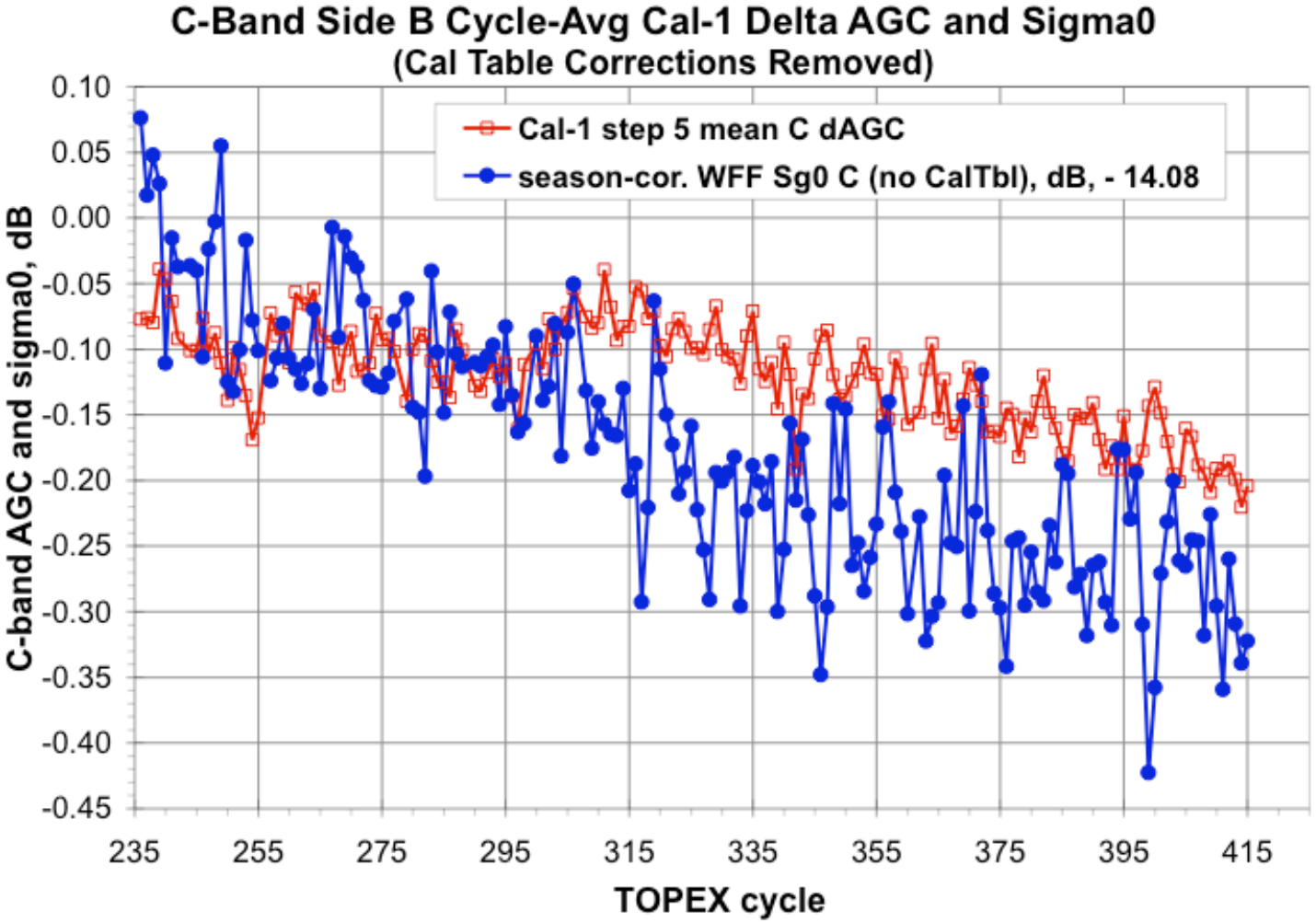

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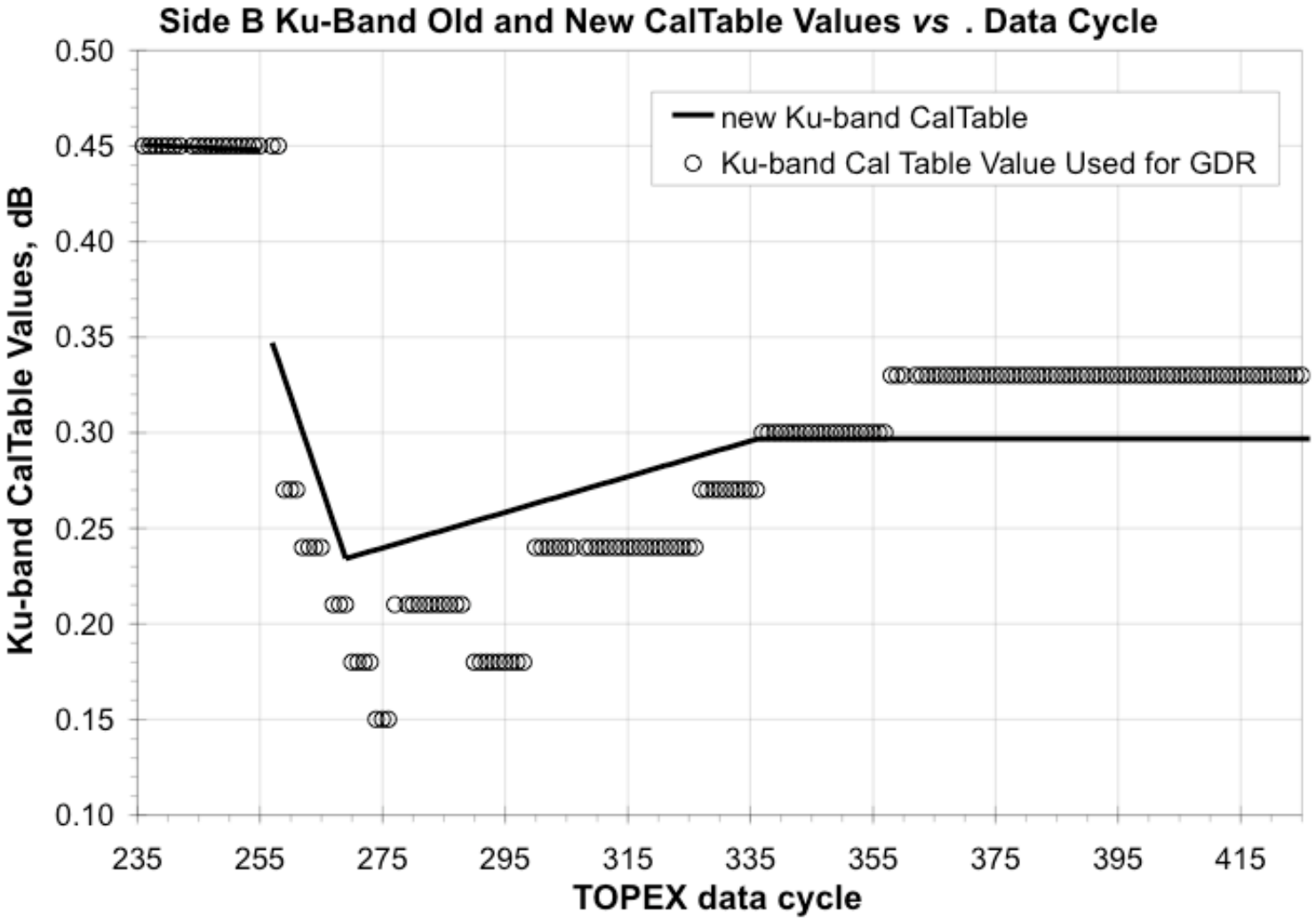

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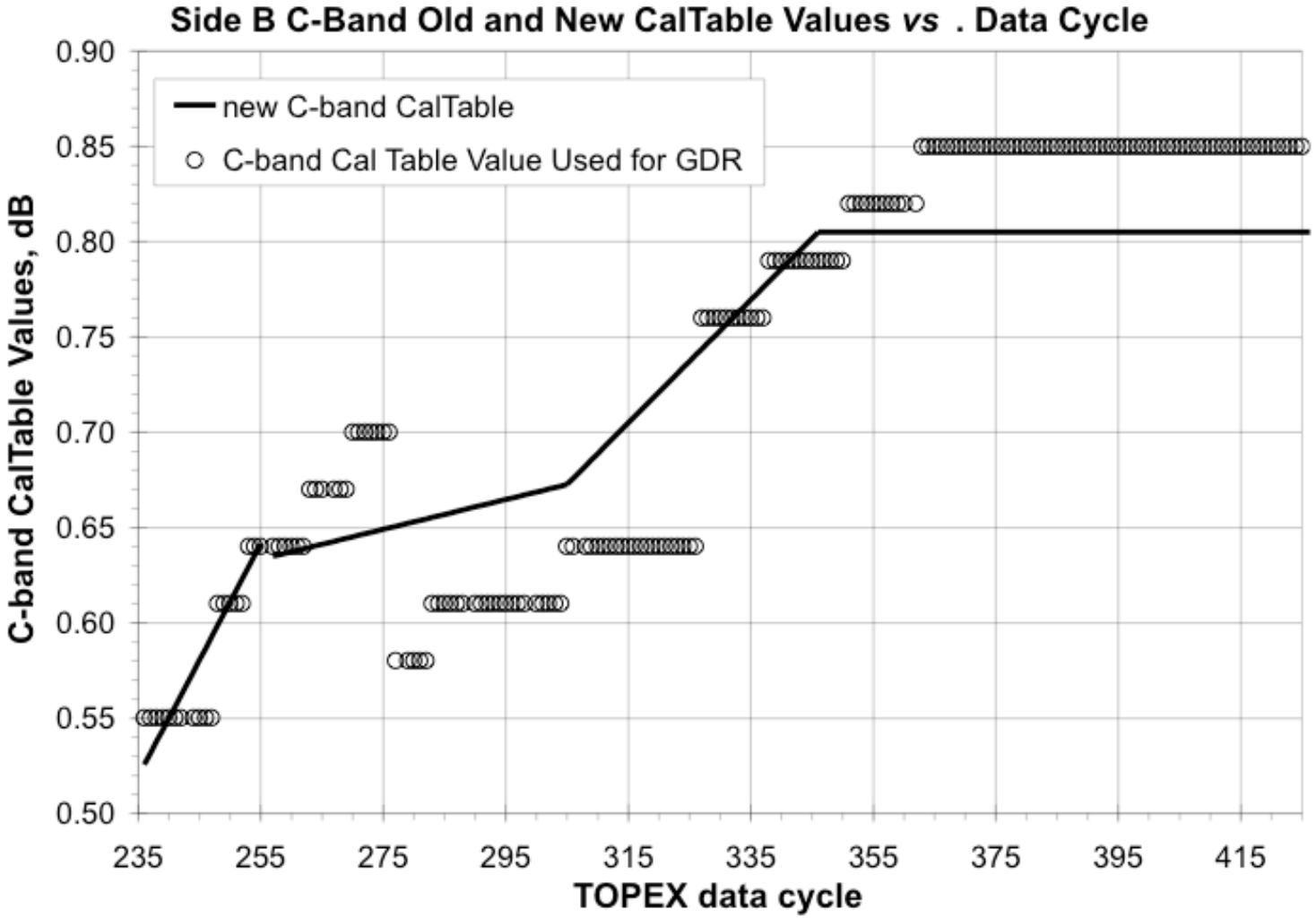

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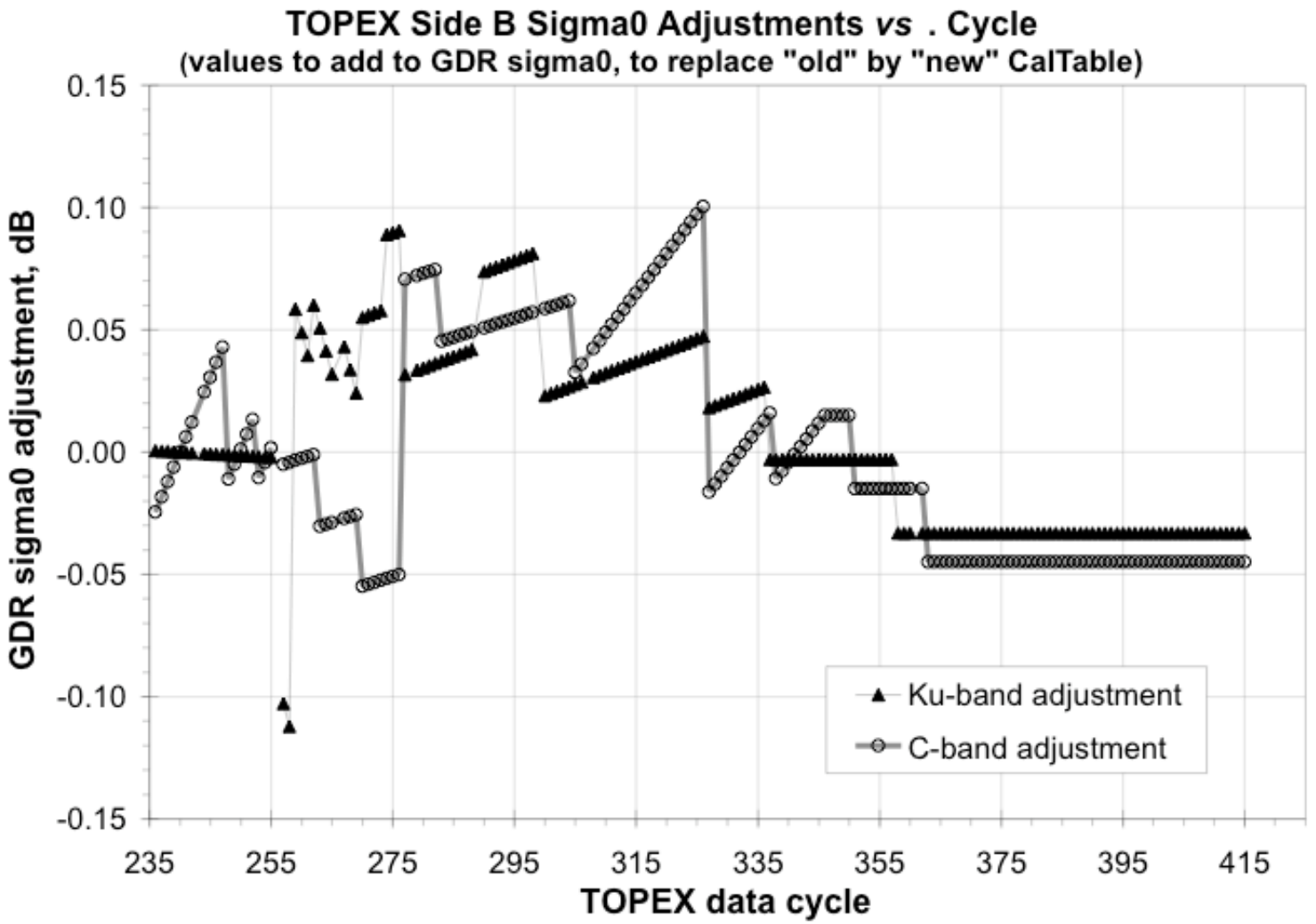
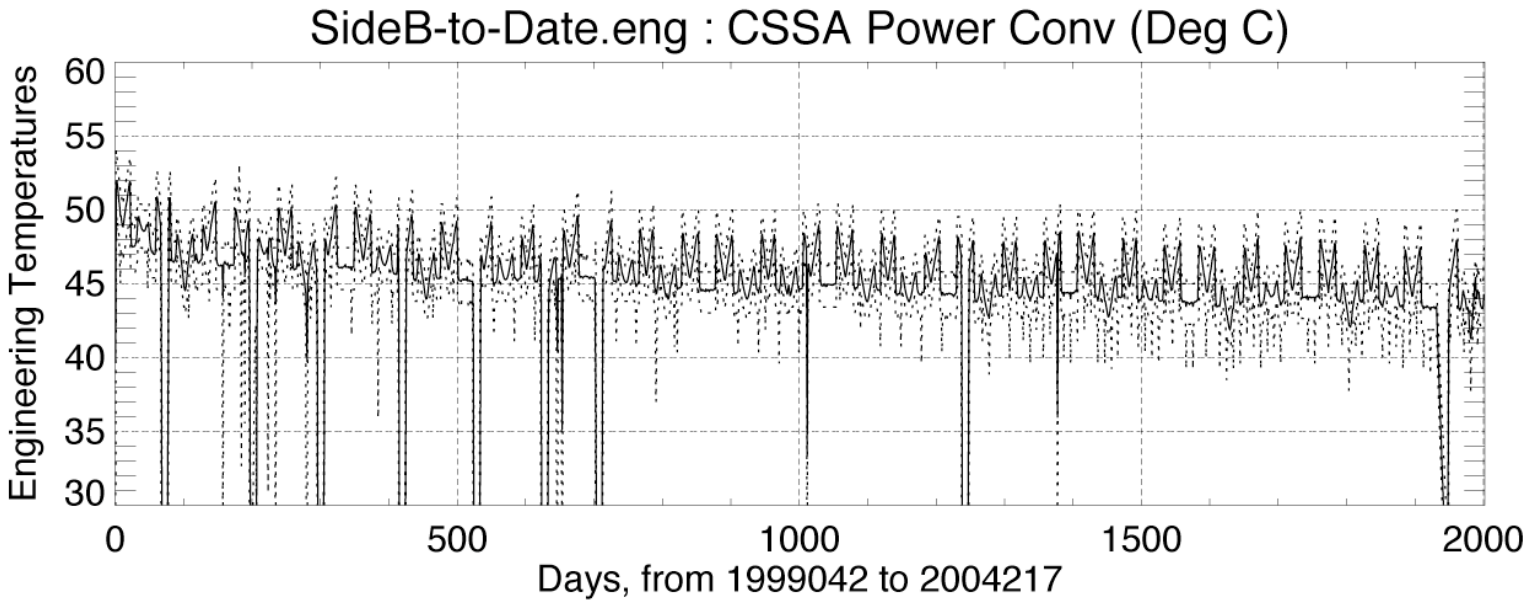
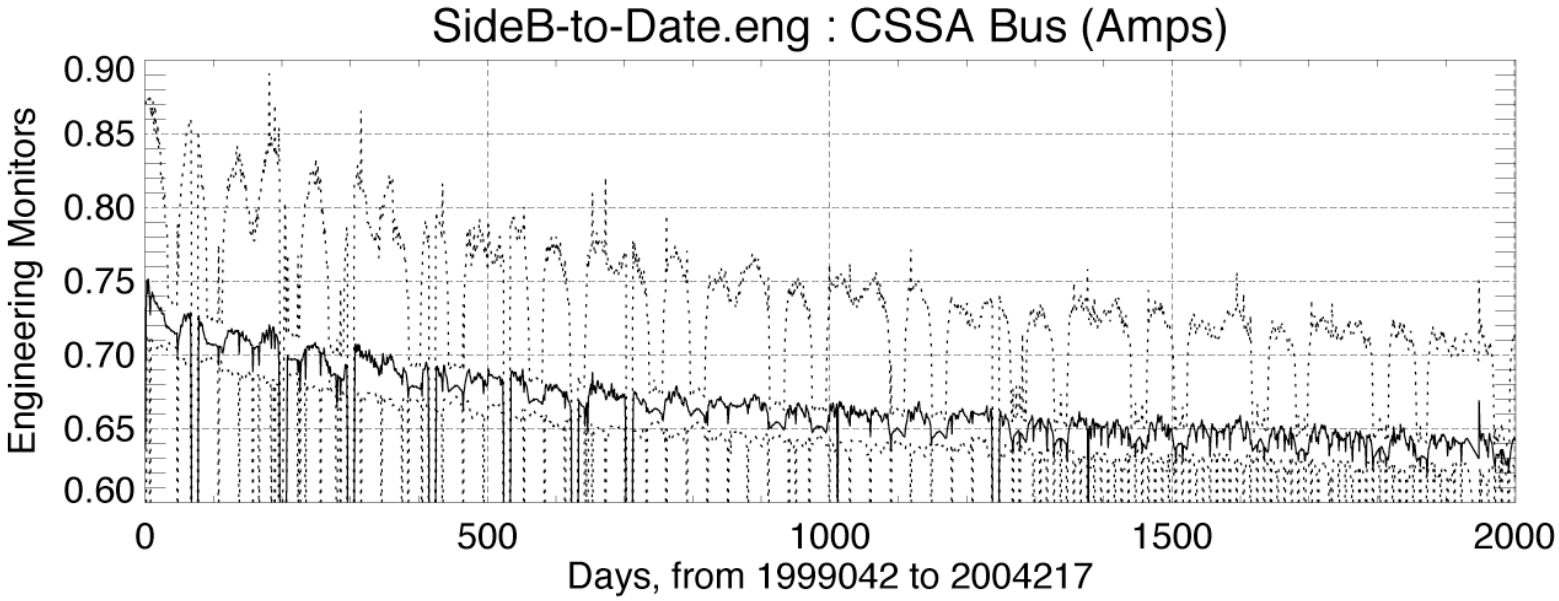

TOPEX Side B Sigma0 Adjustments vs . Cycle
(values to add to GDR sigma0, to replace "old" by "new" CalTable)
GDR sigma0 adjustment, dB
0.15
0.10
0.05
0.00
-0.05
-0.10
-0.15
235
255
275
295
315
335
355
375
395
415
TOPEX data cycle
Ku-band adjustment
C-band adjustment





(24-Hour Averages)

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